Report from Arkansas for 2014 for NCERA-101

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Impact Statement:

In cotton (*Gossypium hirsutum* L.), the growth of pollen tubes through the style has been shown to be especially sensitive to elevated temperatures, but not apparently to water stress. Under elevated temperatures the energy demands of growing pollen tubes cannot be met under heat stress due to decreased source leaf photosynthetic activity. Under water deficit, the cotton pistil seems to be well buffered compared to leaves adjacent in the canopy. There is an increase in antioxidants in the pistil under stress, which helps ameliorate deleterious effects of the stress. These results have helped explained the yield losses and yield variability experienced by Arkansas farmers, and will facilitate the development of methods of ameliorating heat stress for yield stabilization. Current focus is on the effect of high night temperature which seem to be more detrimental than high day temperatures.

New Facilities and Equipment:

We have replaced an older controlled environment chamber with a new CONVIRON PGR15.

Unique Plant Responses:

High temperature stress: resulted in a decrease in soluble carbohydrates and ATP in the flower pistil, which resulted in decreased pollen tube growth and fewer ovules being fertilized. A calcium-augmented antioxidant response in heat-stressed pistils interferes with enzymatic superoxide production needed for normal pollen tube growth. Maintaining a sufficient antioxidant enzyme pool prior to heat stress is an innate mechanism for coping with rapid leaf temperature increases that commonly occur under field conditions.

Water deficit stress decreased photosynthesis and respiration in the leaves, with a concomitant decrease in leaf water potential, whereas the *pistil* water potential remained unaffected. Water stress also increased carbohydrate levels in the pistil and raised antioxidant levels.

Accomplishment Summaries:

In our earlier studies, we investigated heat stress-induced changes in energy reserves and calcium-mediated oxidative status in the pistil, and concluded that the energy demands of growing pollen tubes cannot be met under heat stress due to decreased source leaf activity, and a calcium-augmented antioxidant response in heat-stressed pistils that interferes with enzymatic superoxide production needed for normal pollen tube growth. Comparing the physiological and biochemical responses of a thermosensitive cultivar (ST4554B2RF) from the US Cotton Belt and thermotolerant cultivar (VH260) from Pakistan, we concluded that maintaining a sufficient antioxidant enzyme pool prior to heat stress is an innate mechanism for coping with rapid leaf temperature increases that commonly occur under field conditions.

Published Written Works:

<u>Refereed Journal Articles</u>:

Eecher, F, Oosterhuis, D.M. and Loka, D. 2014. High night temperatures during the floral bud stage increase the abscission of reproductive structures in cotton. *Journal of Agronomy and Crop Science*. 200:191-198.

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Loka, D.A., Oosterhuis, D.M. 2014. Water-deficit stress effects on pistil biochemistry and leaf physiology in cotton (*Gossypium hirsutum*, L.). *South African J Botany*. 93:131-136.

Oosterhuis, D.M. and Cothren, J.T. (Eds.) 2014. Flowering and Fruiting in Cotton. Publ. Cotton Foundation, Memphis, TN. ISBN978-0-939809-08-0. and Translated into Farsi by Dr. Naderi in Iran in 2014. alinaderi@ut.ac.ir. **گلدهی و تولید میوه در پنبه**

Oosterhuis, D.M. (Ed.) 2014. Summaries of Arkansas Cotton Research in 2012. Arkansas Agricultural Experiment Station. Research Series 618. p192.

Oosterhuis, D.M., Loka, D., Kawakami, E.M. and Pettigrew, W.T. 2014. The physiology of potassium in crop production. *Advances in Agronomy*. Vol. 126. 203-233.

Jaureguy, L.M., Chen, P., Brye, K., Oosterhuis, D.M., Mauromoustakos, A., and Clark, J.R. 2013. Potential association between soil and leaf chemical properties, and soybean seed composition. Agricultural Sciences 5:560-570.

Fitzsimons, T., and Oosterhuis, D.M. 2014. Temperature and Related Stress. Compendium of Cotton Diseases. C. Rothrock and T. Kirkpatrick (eds.) Publ. Phytopath Soc. (*in press*)

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Loka, D.A. and Oosterhuis, D.M. 2014. High night temperatures effects on cotton leaf carbohydrate and antioxidant content. *In:* S. Boyd, M. Huffman, and B. Robertson (eds.) CD-ROM *Proc. Beltwide Cotton Conferences*, New Orleans, LA. Jan 7-8, 2013. National Cotton Council of America, Memphis, TN.

Fotzsimons, T. and Oosterhuis, D.M. 2014. Heat stress related adjustments of the cotton flower. CD-ROM pp. 99-108. *In:* S. Boyd, M. Huffman, and B. Robertson (eds.) *Proc. Beltwide Cotton Conferences*. New Orleans, LA. Jan 7-8, 2014. National Cotton Council of America, Memphis, TN.

Pilon, C., Ooosterhuis, D.M. and Loka, D.A. 2014. Genetic variation and heritability for acclimation traits among cotton genotypes under water-deficit stress. CD-ROM p.116. *Proc. Beltwide Cotton Conferences*. New Orleans, LA. Jan 7-8, 2014. National Cotton Council of America, Memphis, TN.

Pilon, C., Ooosterhuis, D.M. and Ritchie, G. 2014. Osmotic adjustment in leaves and ovaries of commercial cotton cultivars under water-deficit stress. CD-ROM pp. 86-90. *In:* S. Boyd, M. Huffman, and

B. Robertson (eds.) *Proc. Beltwide Cotton Conferences*. New Orleans, LA. Jan 7-8, 2014. National Cotton Council of America, Memphis, TN.

RaperR, T.B. Oosterhuis, D.M. et al., 2014. Development of an available soil H_2O index to characterize site water-deficit stress experienced in cotton variety trials. CD-ROM. 84-85. *In:* S. Boyd, M. Huffman, and B. Robertson (eds.) *Proc. Beltwide Cotton Conferences*. New Orleans, LA. Jan 7-8, 2014. National Cotton Council of America, Memphis, TN.

Scientific and Outreach Oral Presentations:

Fitzsimons T.R. and Oosterhuis D.M. 2014. Leaf and ovary carbohydrate adjustments during heat stress before, during, and after anthesis. pp. 85-90. In: D. M. Oosterhuis (Ed.) Summaries of Arkansas Cotton Research 2013. Univ. Arkansas Agric. Exp. Sta., Research Series 610.

Fitzsimons T.R. and Oosterhuis D.M. 2014. Plasma membrane stability during high temperature stress and its effect on electron transport. pp. 76-79. In: D. M. Oosterhuis (Ed.) Summaries of Arkansas Cotton Research 2013. Univ. Ark. Agric. Exp. Sta., Research Series 610.

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Oosterhuis, D.M. 2011. Should we be worried about higher temperatures in crop production? Proc. 14th Annual Conservation Systems Cotton and Rice Conference. Baton Rouge, LA. Feb 1-2, 2011. pp. 8-111.

Oosterhuis, D.M. 2014. Global warming and cotton production. SA Cotton. Vol. 16(2):11-12.

OOSTERHUIS, D.M. 2014. Global warming and cotton productivity. Annual report 2014. Ministry of Industry, Trade and Medium Enterprises, Cotton Arbitration and testing General Organization Information and Document Center, Egypt. p156.

Oosterhuis, D.M., Loka, D. and Raper, T. 2013. Potassium and stress alleviation: Physiological Functions and Management. International Potash Institute. Scientific Paper: *e-ifc* No. 38, September 2014. (http://www.ipipotash.org/en/eifc/2014/38/4/English).

Pilon, C., Ooosterhuis, D.M. and Ritchie, G. 2014. Osmotic adjustment in leaves and ovaries of commercial cotton cultivars under water-deficit stress. pp. 86-90. *In:* S. Boyd, M. Huffman, and B. Robertson (eds.) *Proc. Beltwide Cotton Conferences*. New Orleans, LA. Jan 7-8, 2014. National Cotton Council of America, Memphis, TN.

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Raper, T., Oosterhuis, D., Espinoza, L. and Coomer, T. 2014. A look at potassium deficiency in cotton: canopy reflective indices used to examine plant available K. *Fluid fertilizer Journal.* 22(4):4-6.