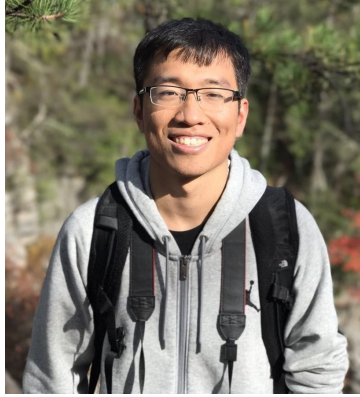


“Function of autophagy during stress response and plant development in maize”



Jie Tang — Ph.D. Defense Seminar
Thursday, July 21, 2022 • 11 a.m.
1062 Roy J. Carver Co-Lab or online

Webex link: <https://iastate.webex.com/iastate/j.php?MTID=m7c3e4bf6bc410be0a0b4152e8bd84dca>

Major: Plant Biology

Major professor: Diane Bassham, Distinguished Professor

Abstract: Autophagy is a major degradation and recycling pathway that delivers cargo such as organelles and proteins to the vacuole. Autophagy is induced in plants by developmental stimuli and by environmental stresses such as heat, drought, and salt. Although many important functions and regulation mechanisms have been characterized in *Arabidopsis thaliana*, information about autophagy in crop plants is still limited. A better understanding of autophagy in crop species during development processes and under stress conditions may lead to beneficial agricultural applications. This dissertation summarizes my work on studying the function of autophagy during stress response and plant development in maize (*Zea mays*).

Environmental stresses such as heat stress disrupt protein folding and cause the accumulation of unfolded proteins in the endoplasmic reticulum (ER) lumen, termed ER stress. Under ER stress, plants activate the unfolded protein response (UPR) and autophagy to help mitigate the stress. Here I demonstrate that autophagy is activated by chemical ER stress inducers, dithiothreitol (DTT) and tunicamycin, in maize. Autophagy is active at both pro-survival stage and pro-death stage during persistent ER stress. To better understand the activation of autophagy in the field, I used a controlled environment facility called the Enviratron to simulate field conditions, using temperature as a varying parameter to study the effect of heat stress on autophagy. Autophagy in a W22 inbred line is upregulated in the virtual afternoon at a maximum daily temperature of 35°C or 37°C, but not upregulated at a maximum daily temperature of 31°C or 33°C. The upregulation of autophagy co-occurs with the induction of the UPR. I confirmed the findings in the Enviratron by analyzing samples collected on a hot summer day from field-grown plants. I also identified two autophagy-deficient mutants, *atg10-Mu* and *atg10-Ds*. Under DTT-triggered ER stress, UPR is upregulated in *atg10* mutants while autophagy is constitutively activated in a UPR-deficient *bzip60-2* mutant. In addition, genes encoding heat shock proteins are upregulated in heat-stressed field-grown *atg10* mutants.

Autophagy has been shown to function at various stages during plant's life cycle, such as vegetative growth, reproductive development, seed development and senescence. Harnessing the autophagy-defective *atg10* mutants, I demonstrate that autophagy is involved in determining flowering time and grain yield in maize. Flowering is delayed in *atg10* mutants. More importantly, grain yield is significantly reduced in *atg10* mutants. The reduction in yield is due to reduction in kernel size, kernel weight and kernel number. In addition, maternal genotype causes the kernel and ear phenotypes in *atg10* mutants.

In summary, this dissertation demonstrates that autophagy is involved in response to ER stress and heat stress in maize. During the development of maize plants, autophagy functions in the determination of flowering time and grain yield.

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