Grain abortion and yield stability under drought: a key role for growth processes in reproductive organs

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Selected talk

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Yield maintenance under drought in maize (Zea mays) is associated to flowering synchrony which requires the rapid extension of styles and stigma (silks) to be accessible for pollen. Most analyses of the control of grain abortion in maize conclude that abortion is linked to a carbon shortage in ovaries, but they have been performed with a common protocol avoiding the impact of water deficit on silk growth. A series of recent works attempt to reconcile the developmental view that abortion is due to the timing of silk growth, with the molecular view that abortion is linked to the sugar metabolism in ovaries. They analyse expansive growth, transcript abundances, concentrations/amounts of sugars and enzyme activities in silks and ovaries located at different positions along the ear. A switch to abortion occurs 2-3d after first silk emergence in water-stressed plants, when silk growth stops simultaneously for all ovary cohorts, and explains abortion rates in different treatments and positions on the ear. The metabolic analysis supports the view that the first molecular events occur in silks rather than in ovaries, and involve genes affecting expansive growth rather than sugar metabolism. Sugar availability is preserved in ovaries until the switch to abortion, and the disruption of carbon metabolism only occurs after this switch. Hence, changes in metabolite contents, transcript amounts and enzyme activities involved in ovary sugar metabolism would be a consequence rather than a cause of the beginning of ovary abortion. Patterns of silk growth responses to environment share common features with those of leaf growth and suggest that both physiological and genetic controls under drought involve mechanisms associated to cell wall properties and water entry into growing cells, rather than carbon metabolism. Those findings have large consequences for breeding drought tolerant maize, and for modelling grain yields in water deficit.

Keywords: maize, water deficit, silk growth, ovary abortion, carbon metabolism