



西北农林科技大学
Northwest A&F University

中国植物营养与肥料学会2019年度学术年会

供氮影响玉米吐丝后碳累积与分配的生理机制

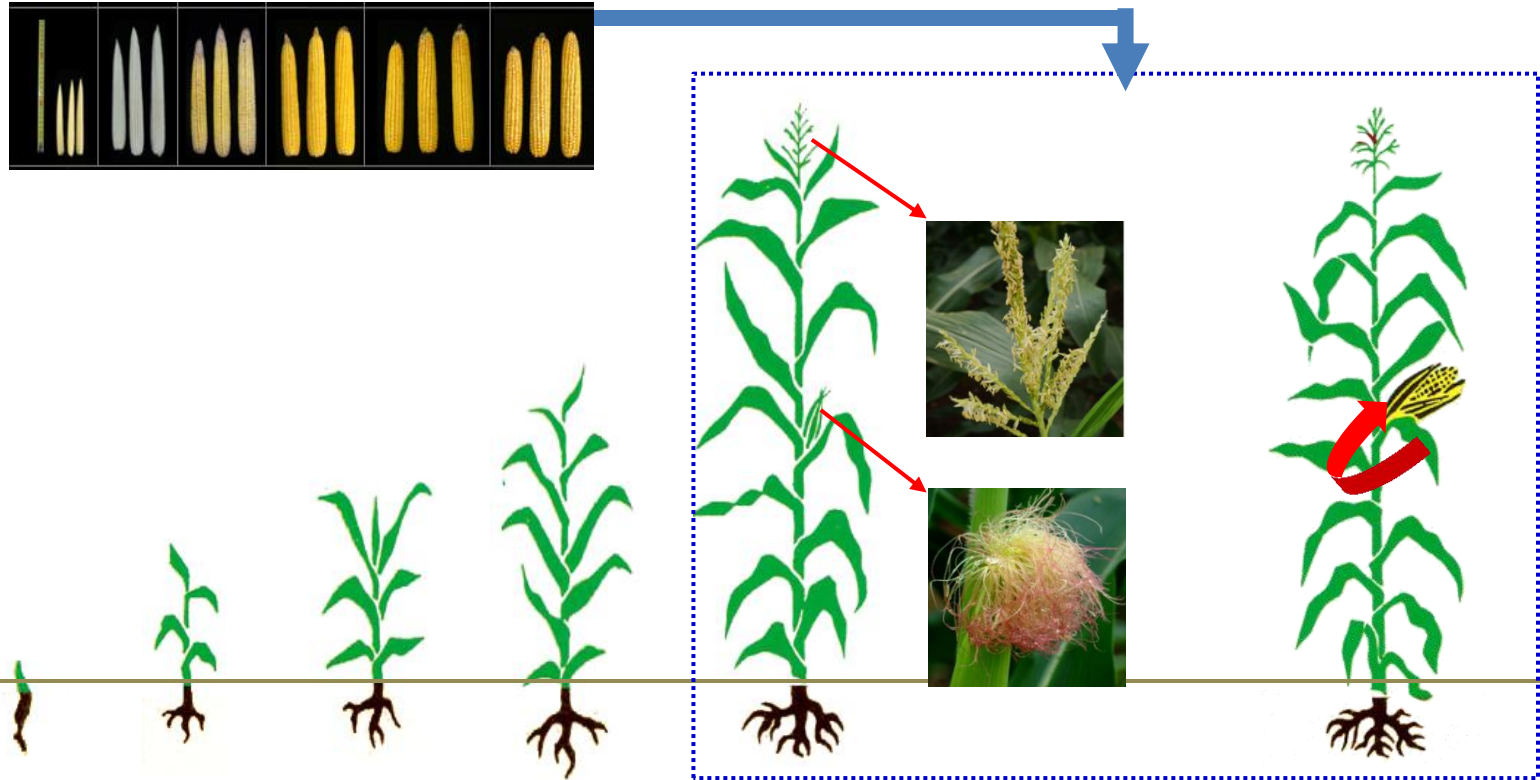
宁鹏

西北农林科技大学·资源环境学院

2019年8月8日 重庆



玉米吐丝后碳水化合物积累与籽粒产量

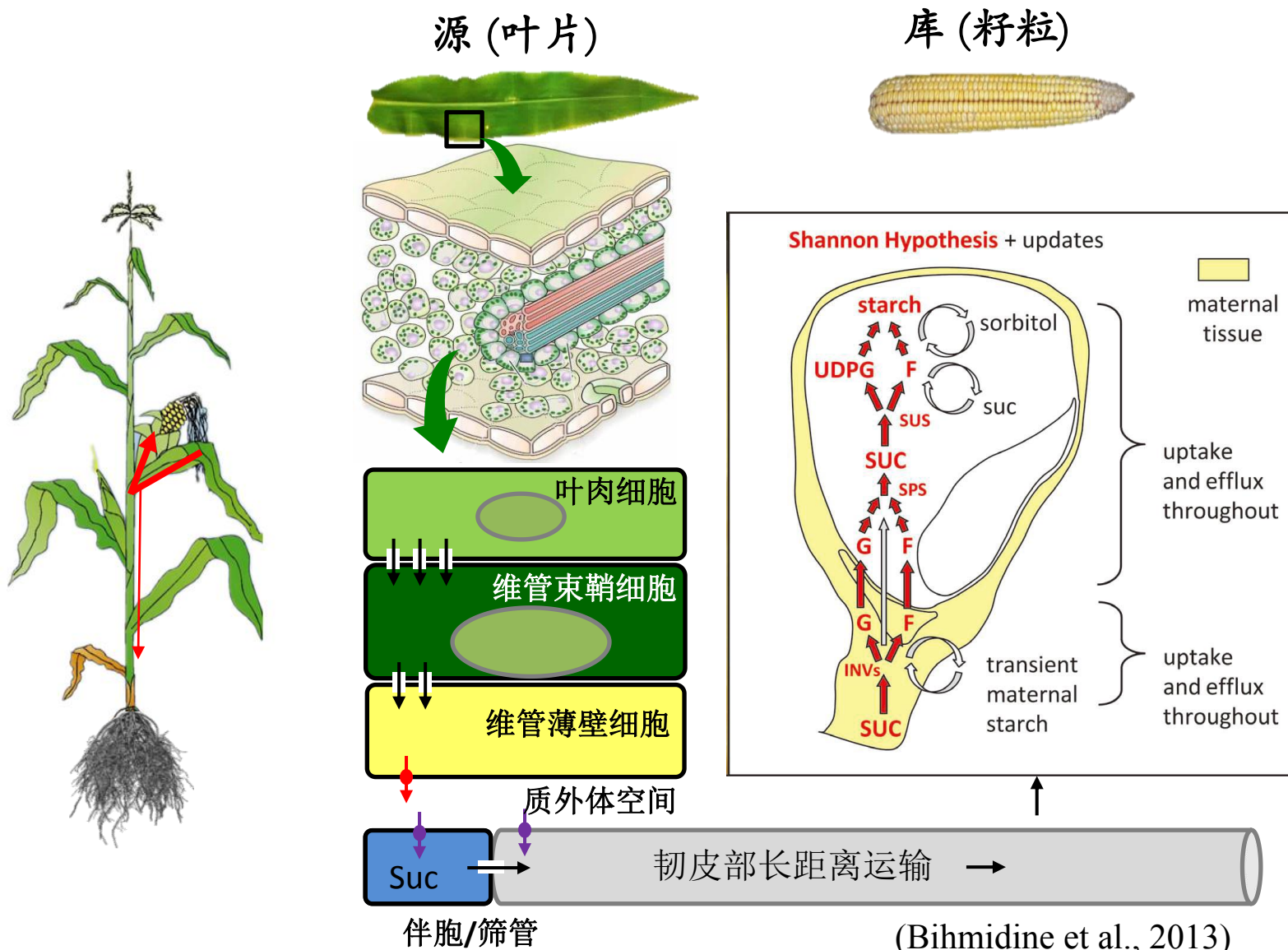


开花期/吐丝期

- 玉米籽粒中的碳水化合物几乎全部来自吐丝后光合作用

(Hirel et al., 2007; Lee and Tollenaar, 2007; Ning et al., 2013)

碳水化合物的分配与运输



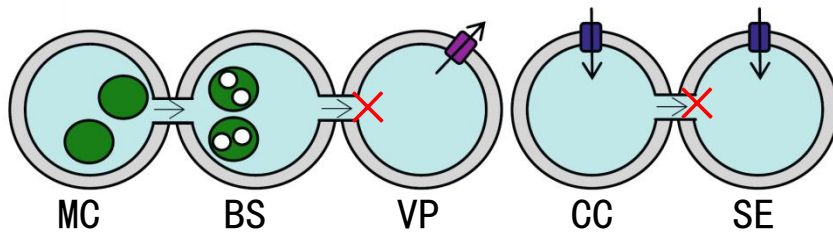
影响玉米叶片中碳输出的关键过程

Maize mutants that function in carbs partitioning :

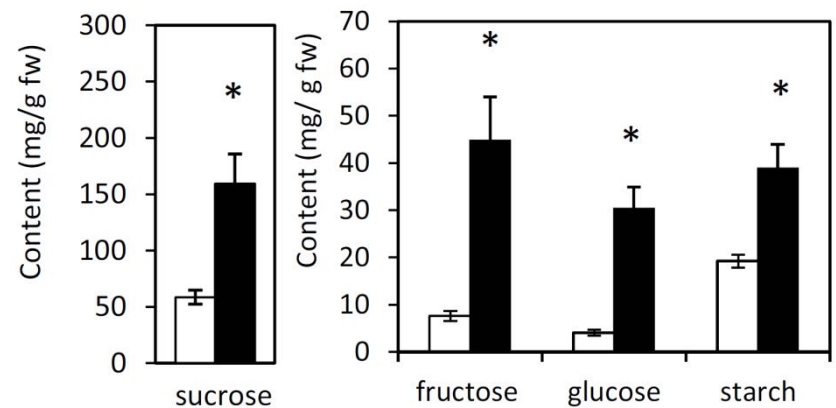
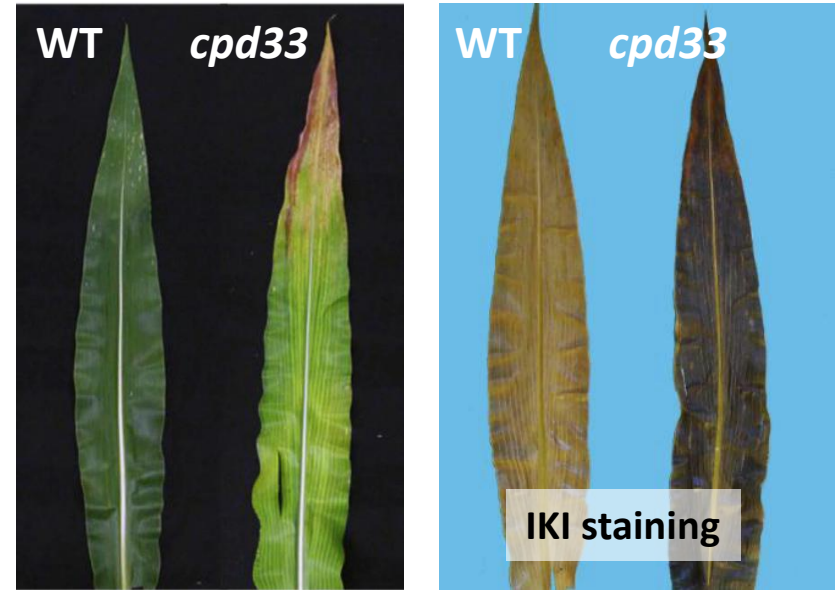
sxd1: sucrose export defective1,
tdy1: tie-dyed1; *tdy2*: tie-dyed2,
sut1: sucrose transporter1,
Cpd1: Carbohydrate partitioning defective1



- Block by callose (β -glucan, 葡聚糖)
- Dysfunction of transporters



(Russin et al., 1996; Botha et al., 2000;
 Ma et al., 2008; Slewinski et al., 2009;
 Baker et al., 2016; Julius et al., 2018)



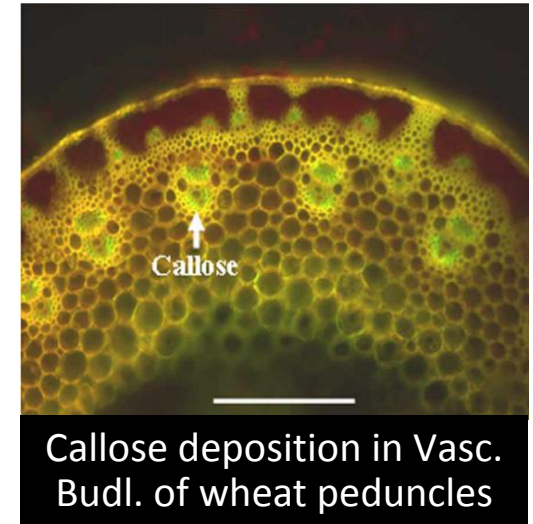
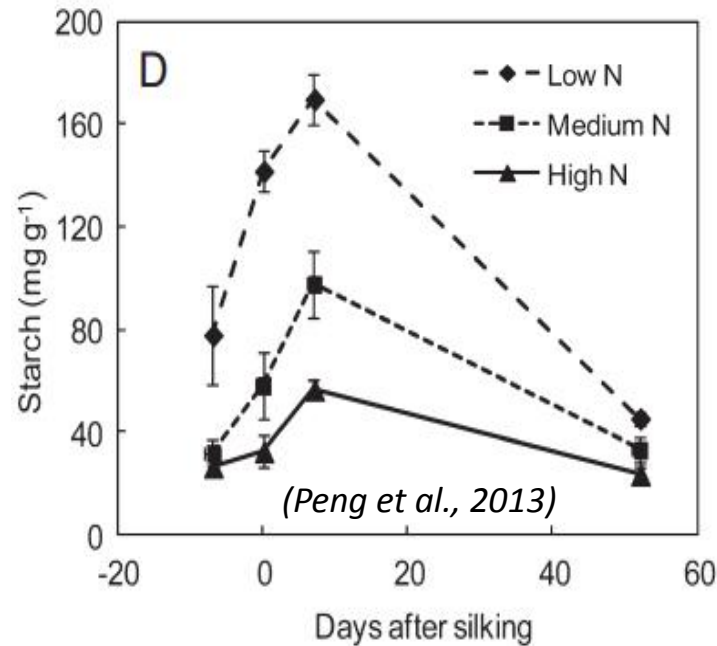
(Tran et al., 2019, Mol. Plant)

氮素供应影响玉米碳累积与分配的可能原因



N_0 N_{200} N_0 N_{200}

(Ning Peng)



(Kong et al., 2013)

Hypothesis:

- (1) Source-sink regulation
- (2) Sucrose and starch metabolism
- (3) Sucrose export (symplastic pathway and phloem loading)

氮对玉米穗位叶片光合作用的影响

材料:

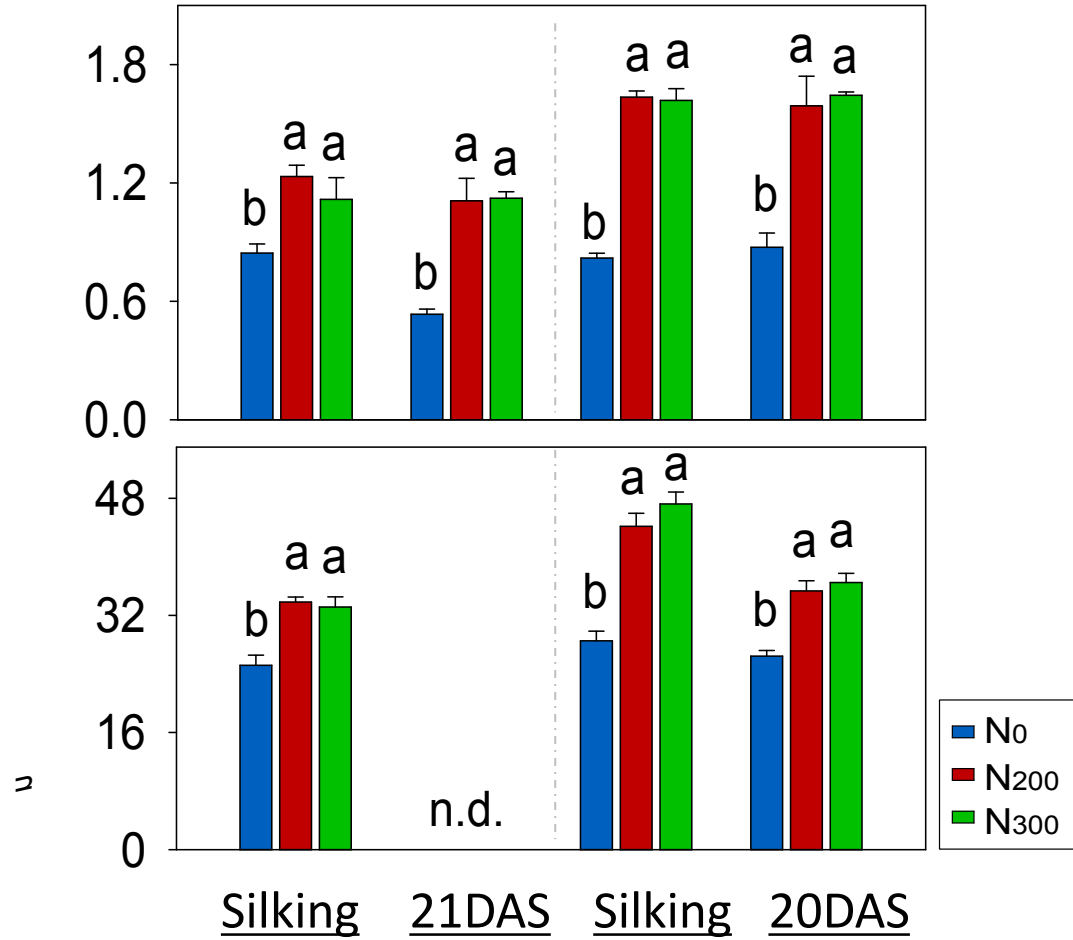
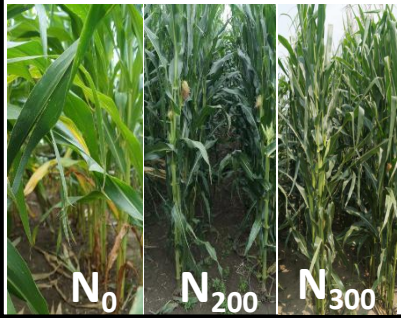
Pioneer 32D79

氮水平:

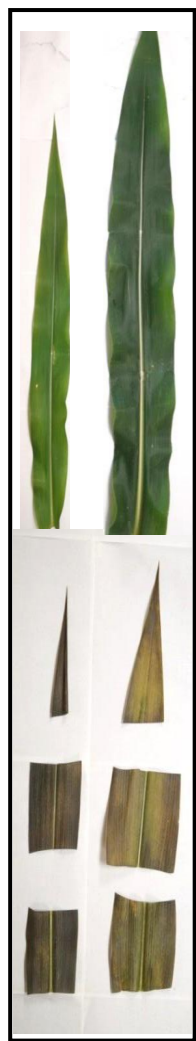
NO, N200, N300

吐丝期、+20天

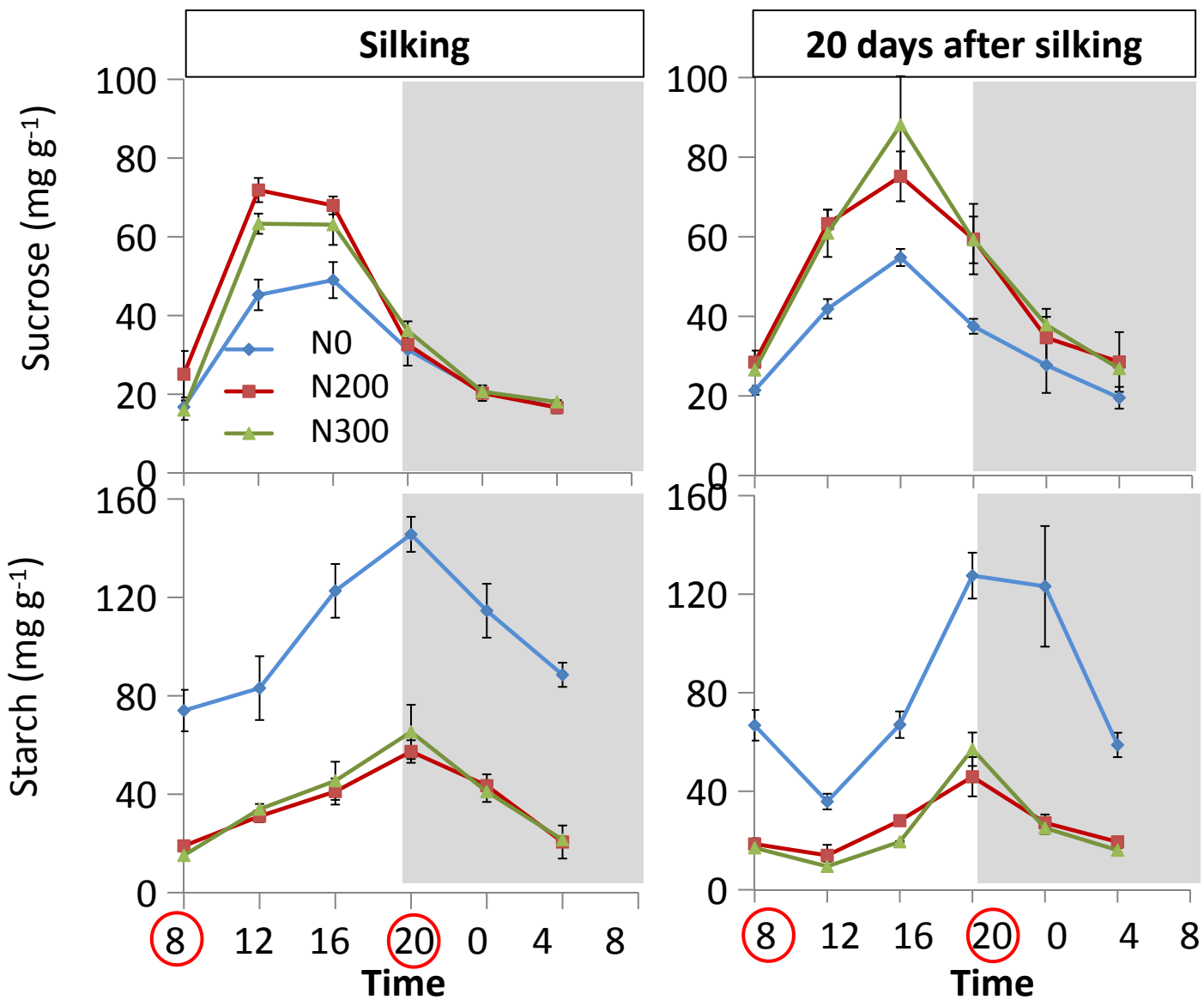
叶、穗



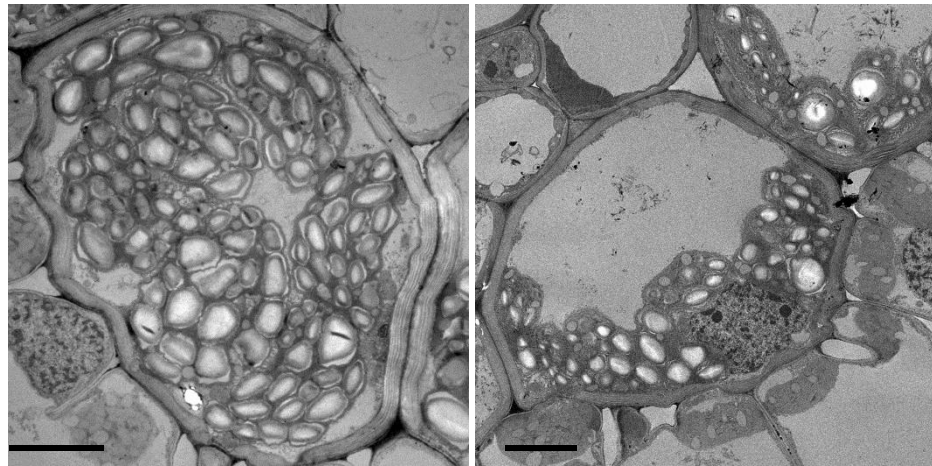
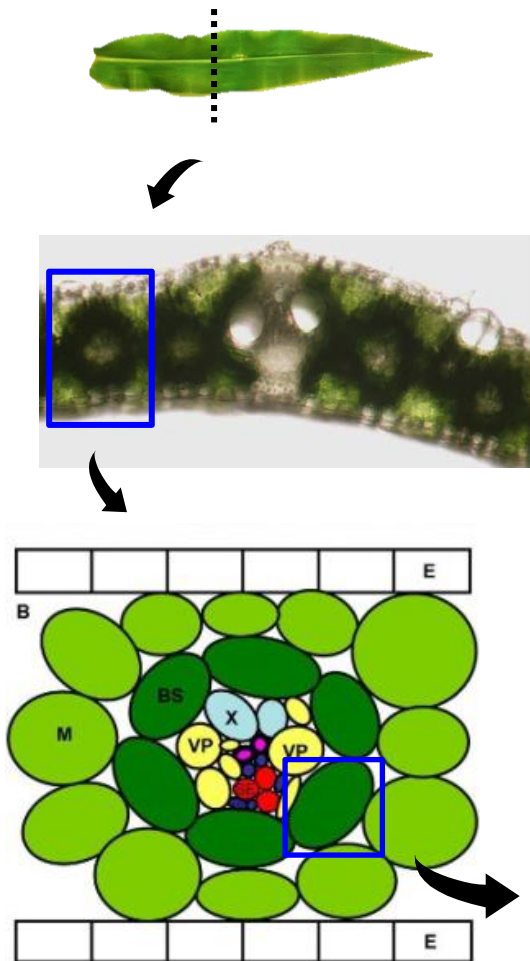
低氮玉米穗位叶片累积大量碳水化合物（淀粉）



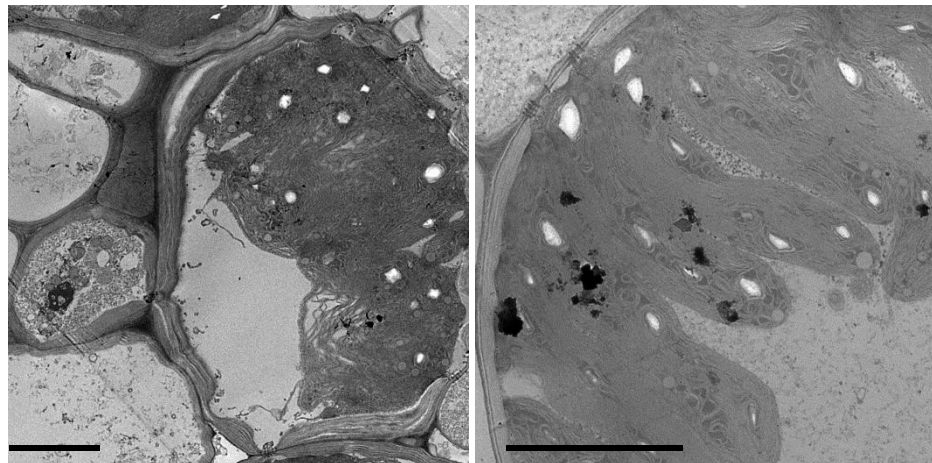
N_0 N_{200} N_{300}
碘染色



玉米叶片淀粉粒形态观察



N₀



N₂₀₀

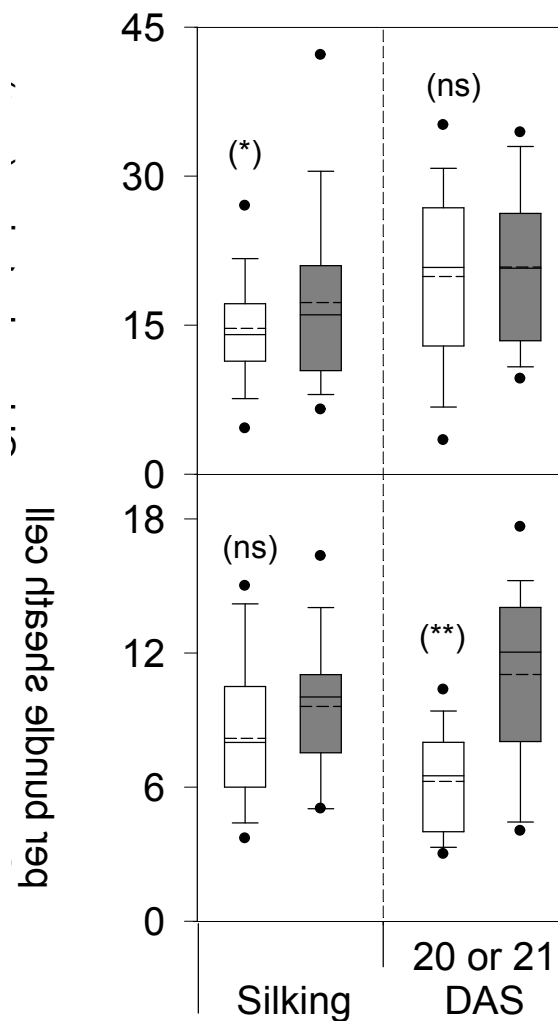
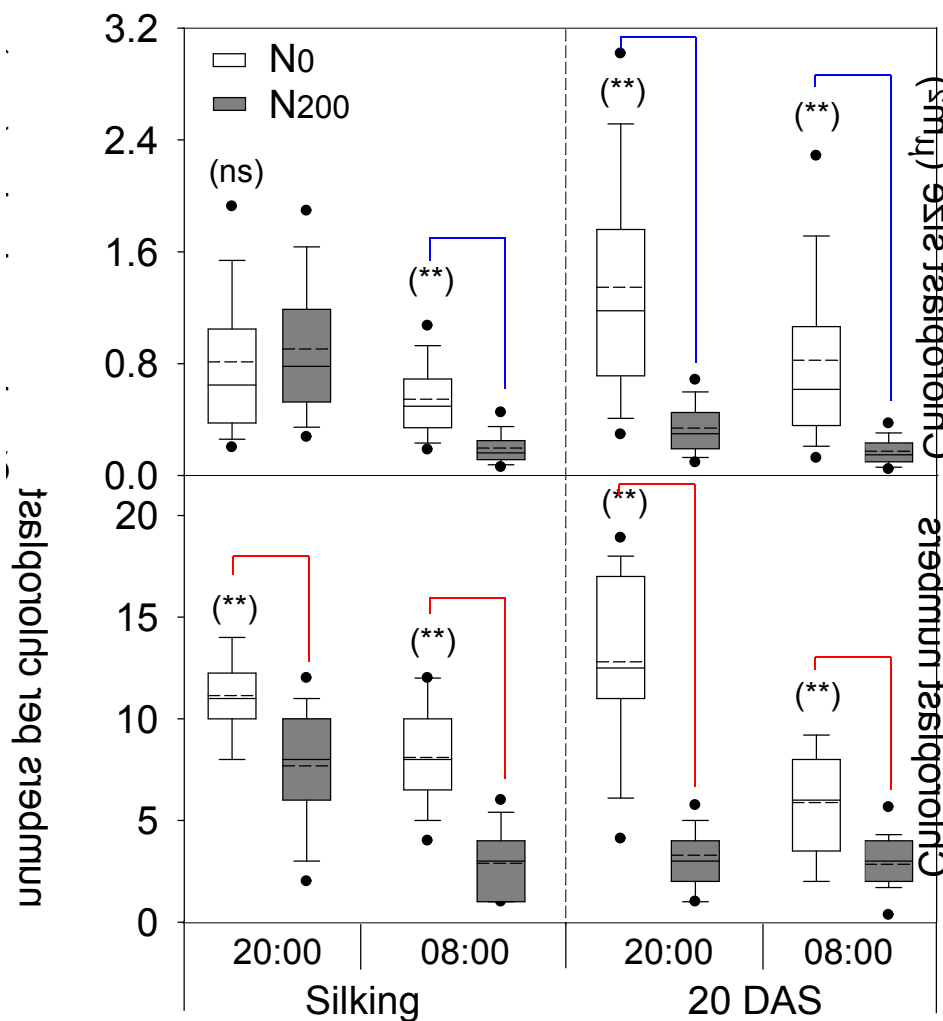
20:00

08:00

20 days after silking

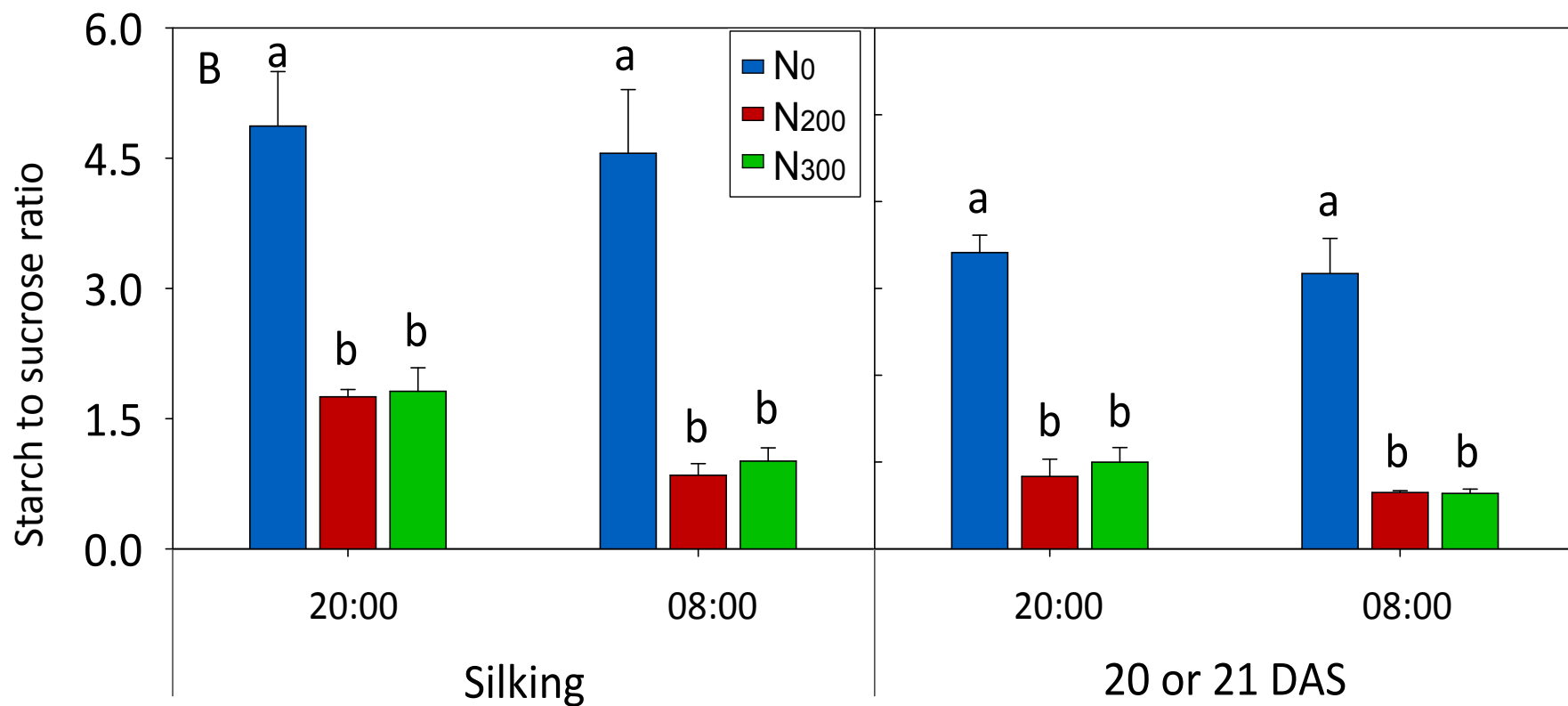
Scale bar=5 μm

低氮玉米叶片中淀粉粒较大、单位叶绿体中数目较多

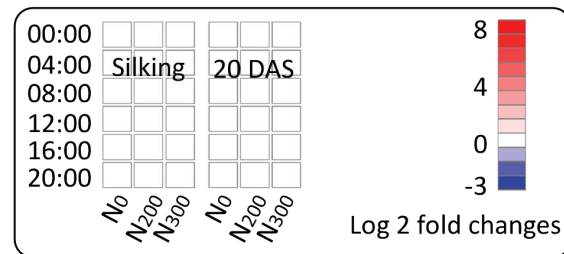
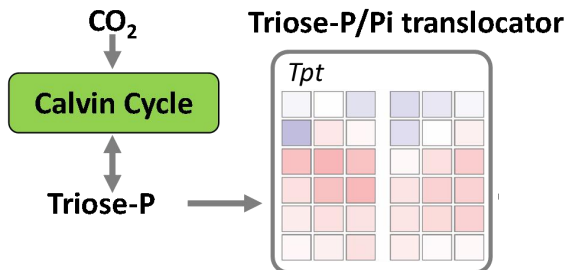
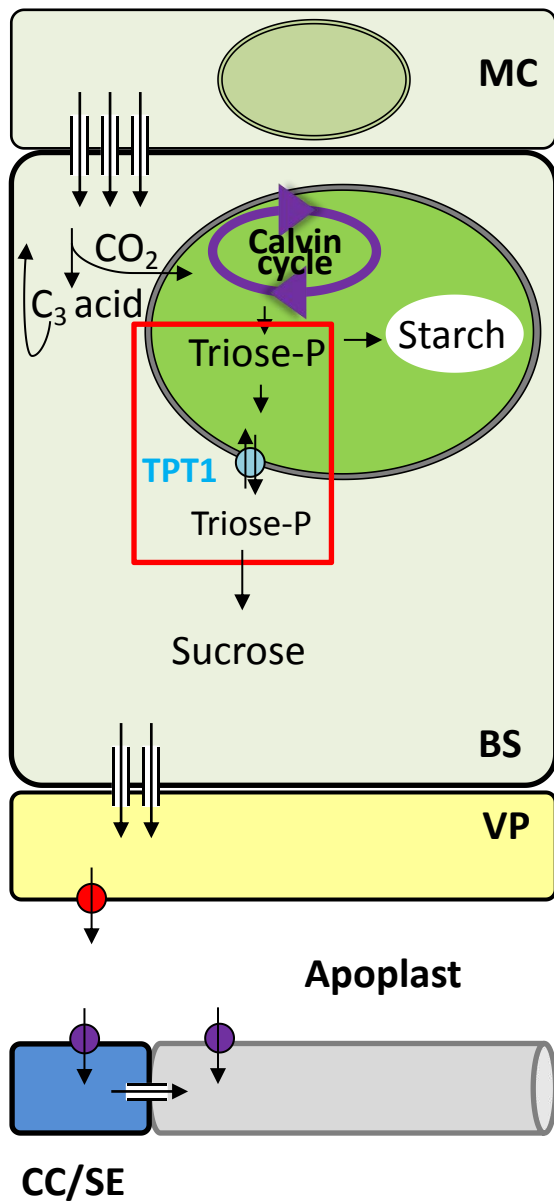


(* , $P < 0.05$; ** , $P < 0.01$; ns, not significant)

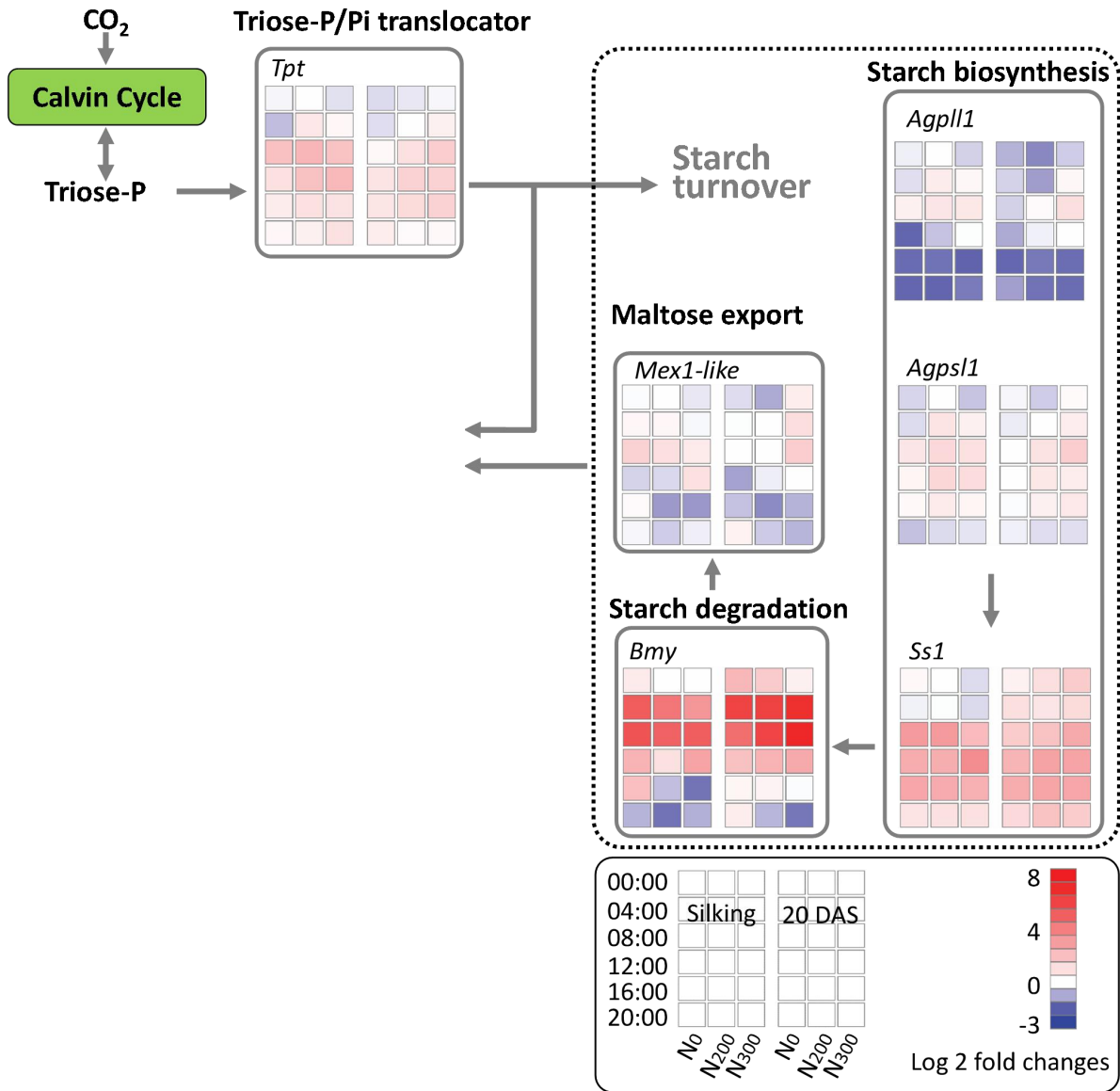
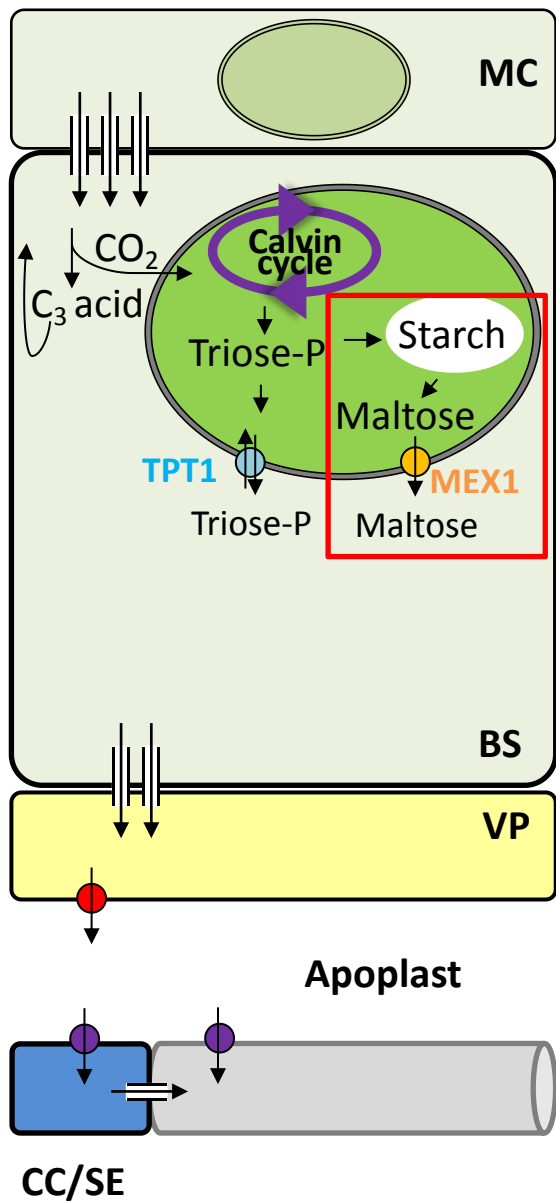
低氮导致光合产物更多地向淀粉合成方向分配



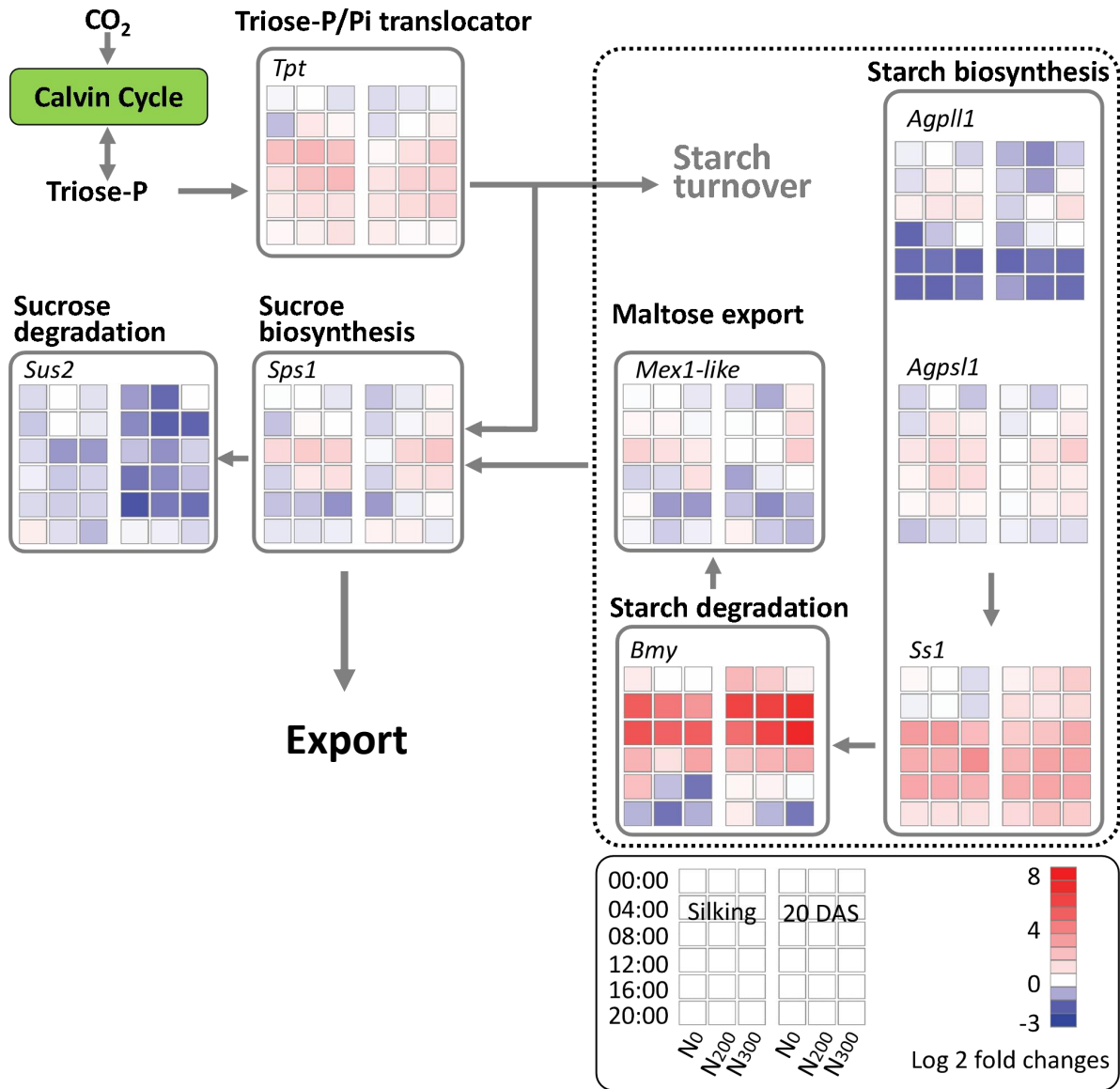
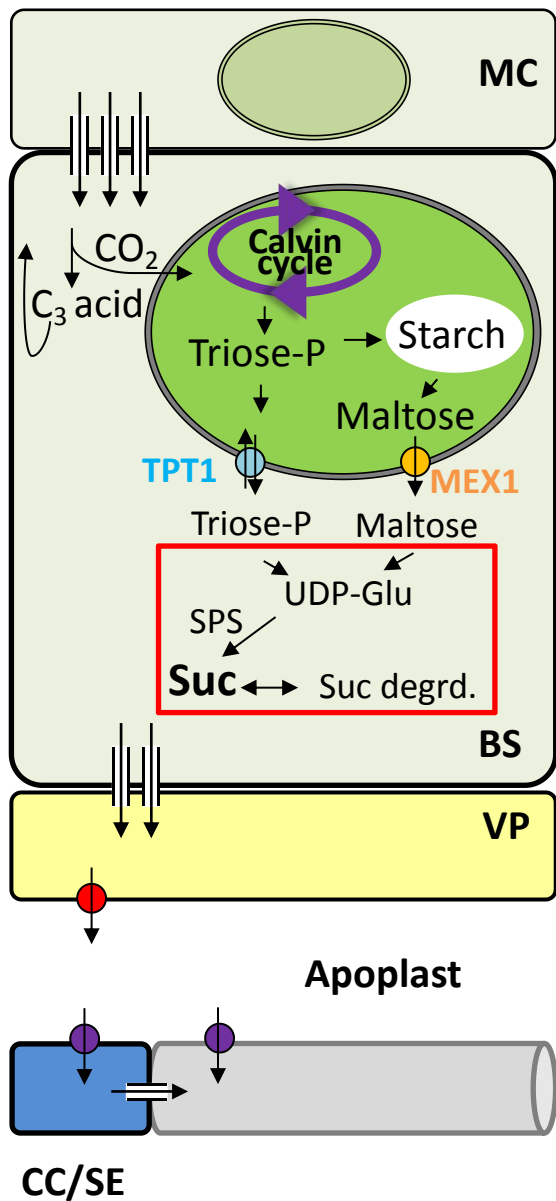
穗位叶中蔗糖与淀粉代谢的关键基因表达分析



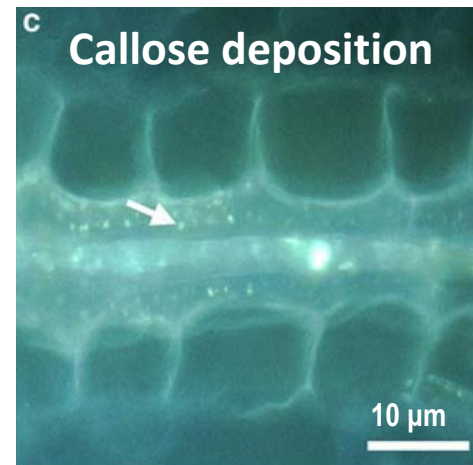
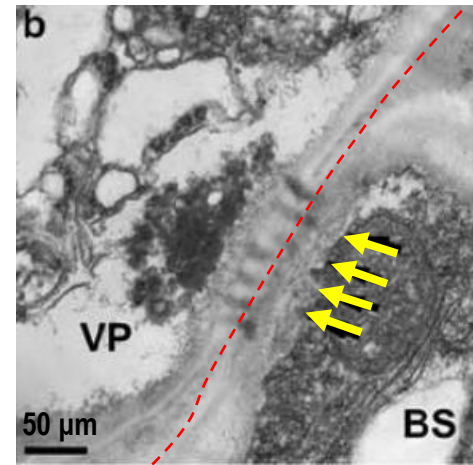
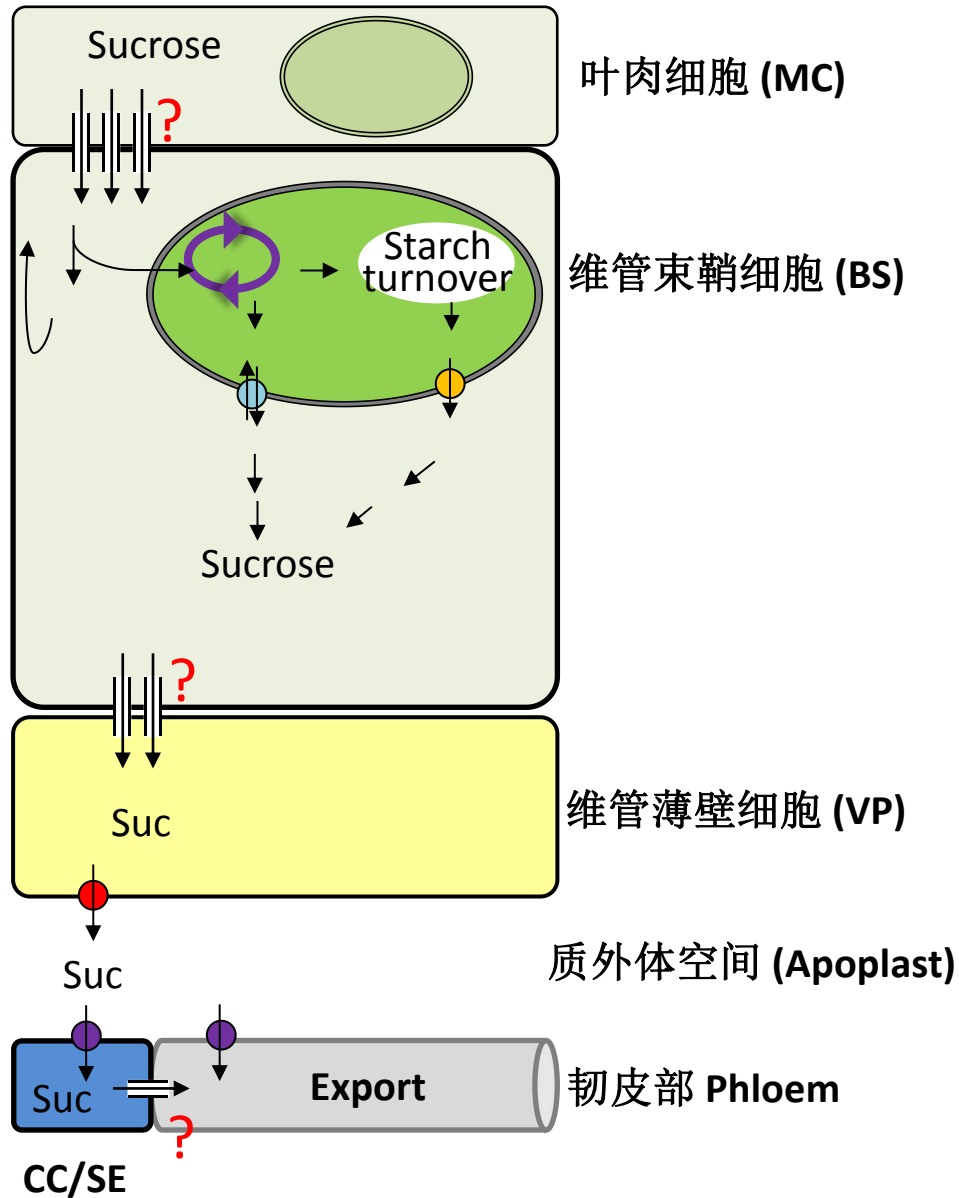
穗位叶中蔗糖与淀粉代谢的关键基因表达分析



穗位叶中蔗糖与淀粉代谢的关键基因表达分析

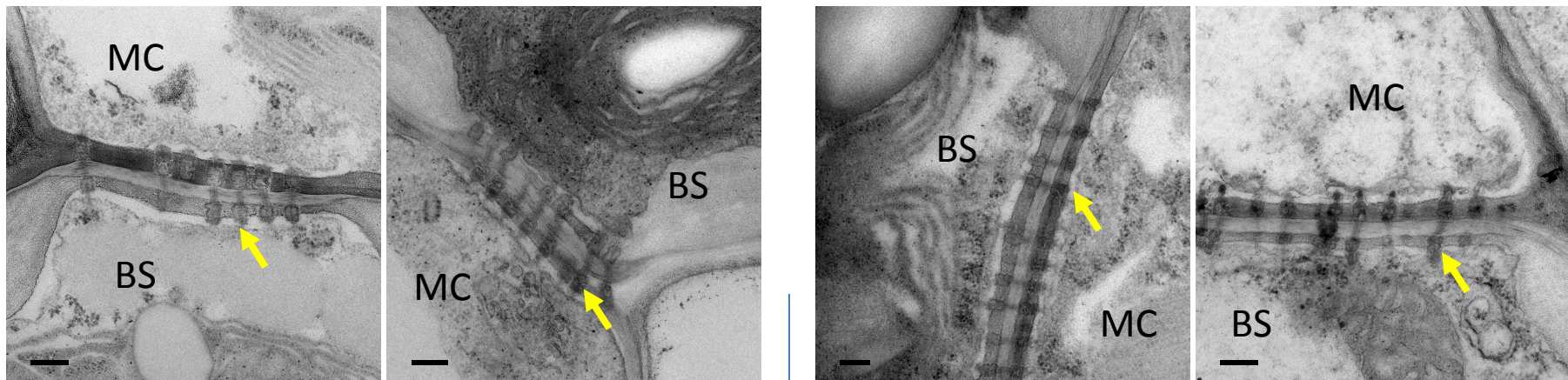


叶片中蔗糖输出的共质体途径 (胞间连丝)

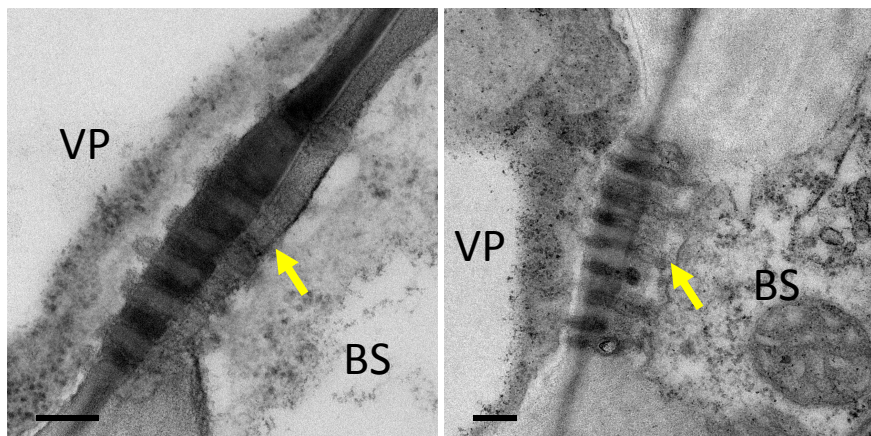


sxd1-1 chlorotic leaf
(Ma et al., 2008)

低氮和正常供氮玉米叶片胞间连丝形态类似



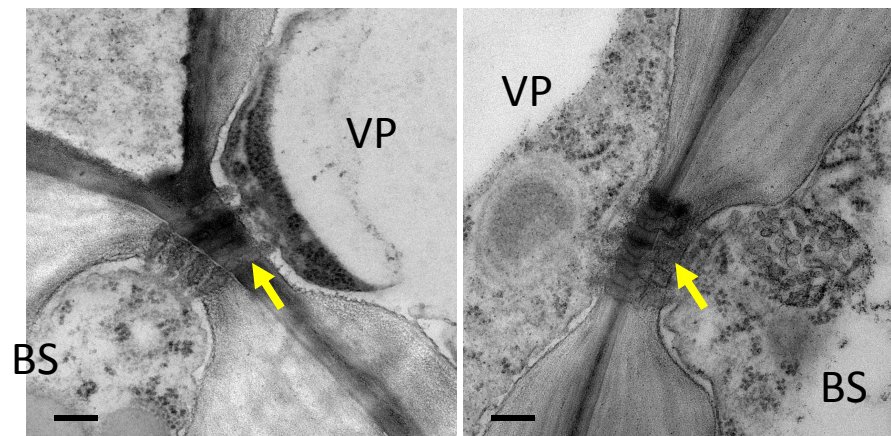
Scale bar=200 nm



N_0

N_{200}

Silking



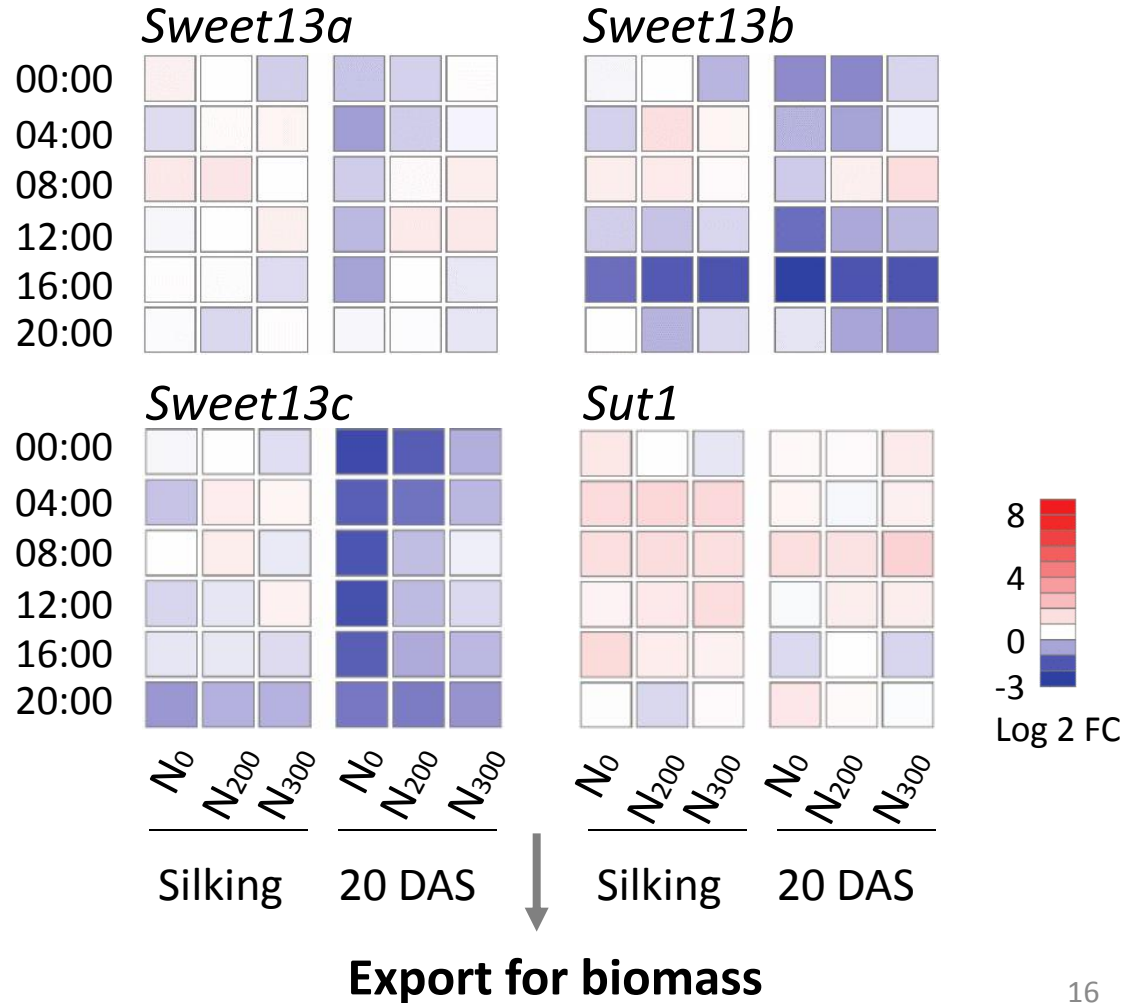
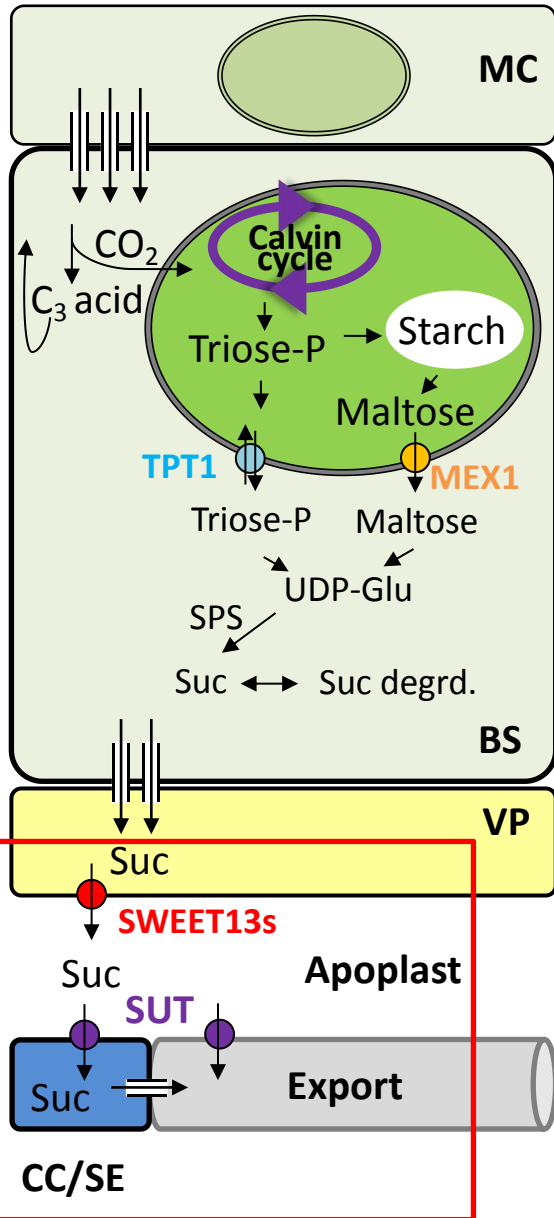
N_0

N_{200}

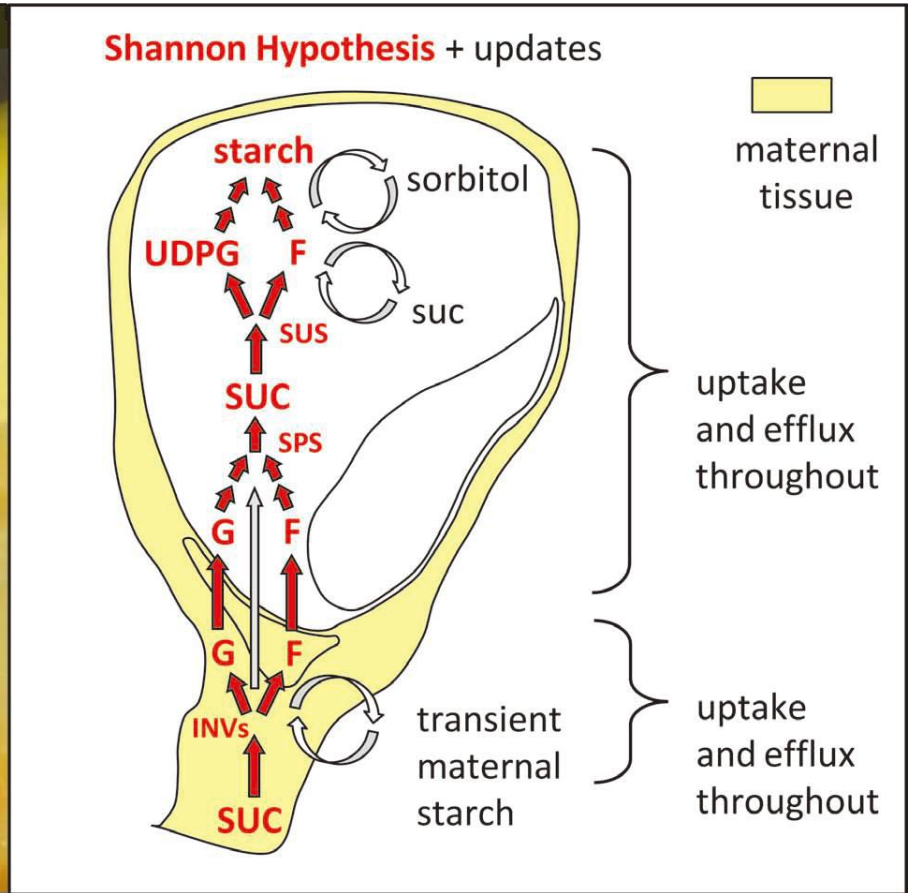
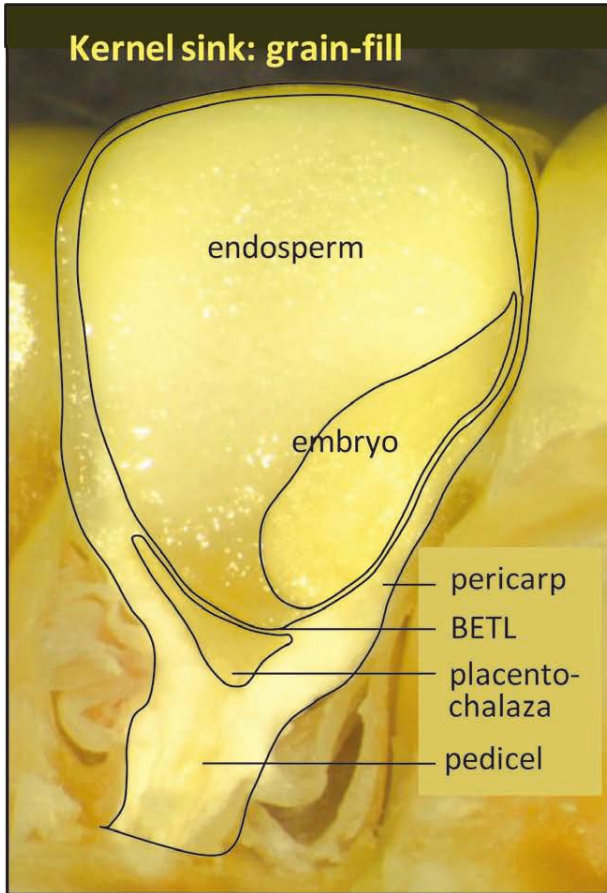
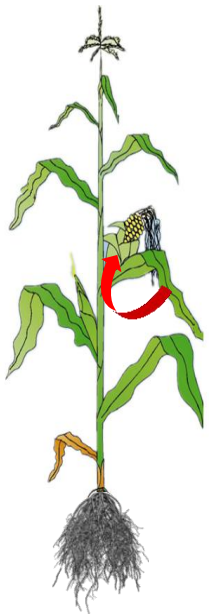
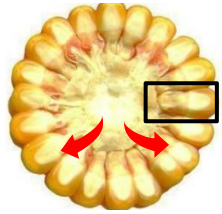
20 DAS

穗位叶中蔗糖韧皮部装载相关基因表达分析

SWEET: sugars will eventually be exported transporter
 SUT: sucrose transporter

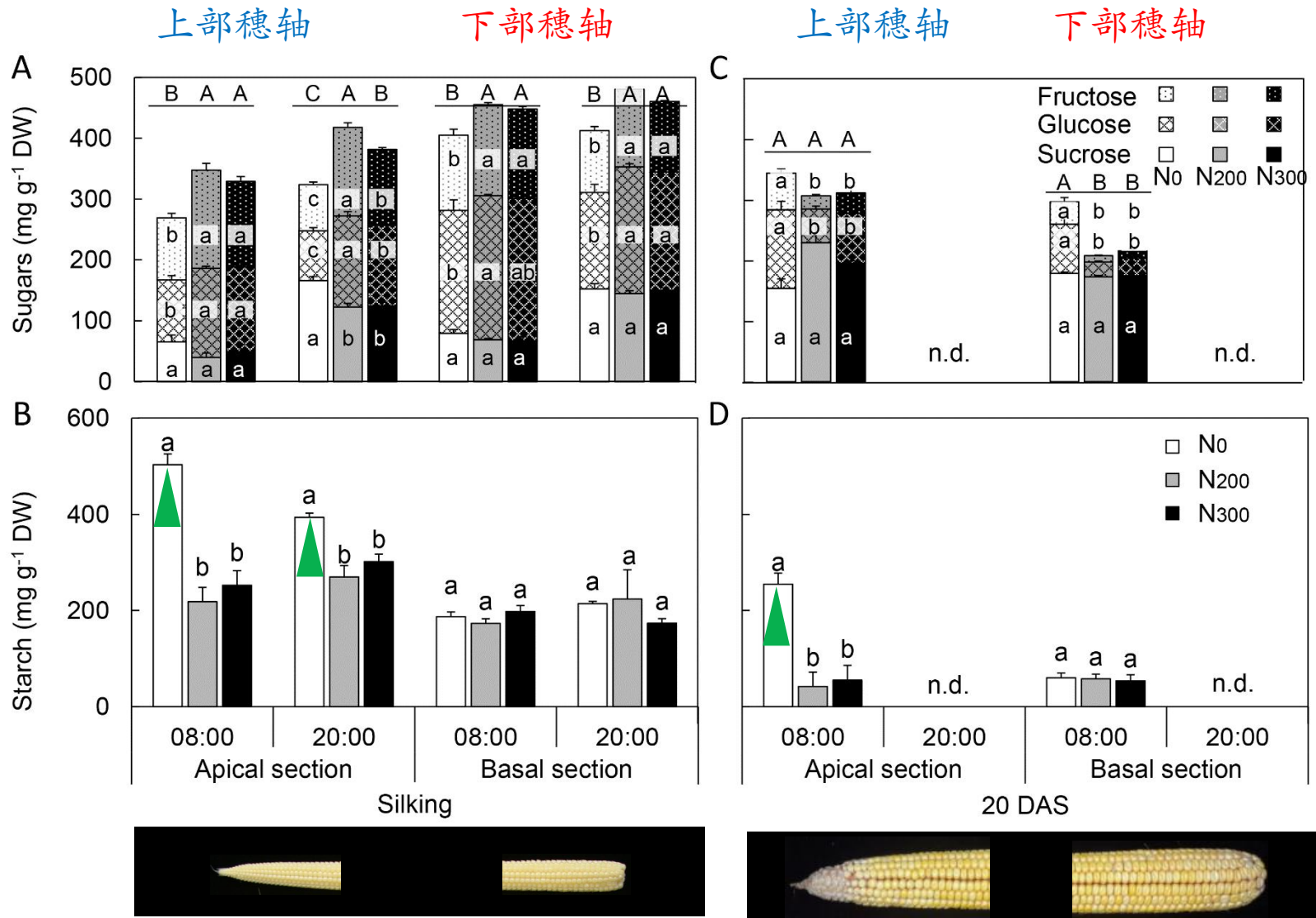


玉米雌穗中糖类转化、运输和储存

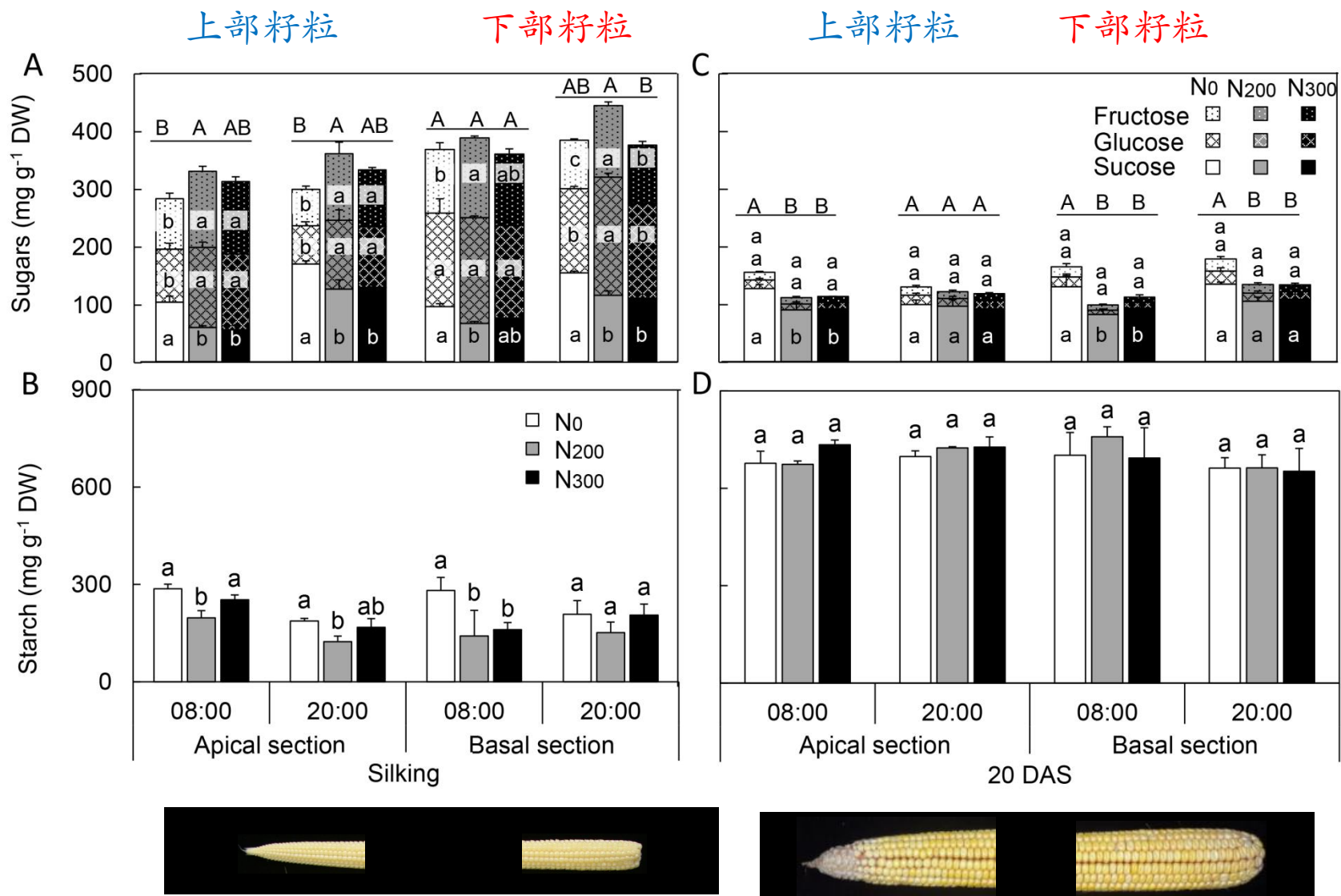


(Bihmidine et al., 2013)

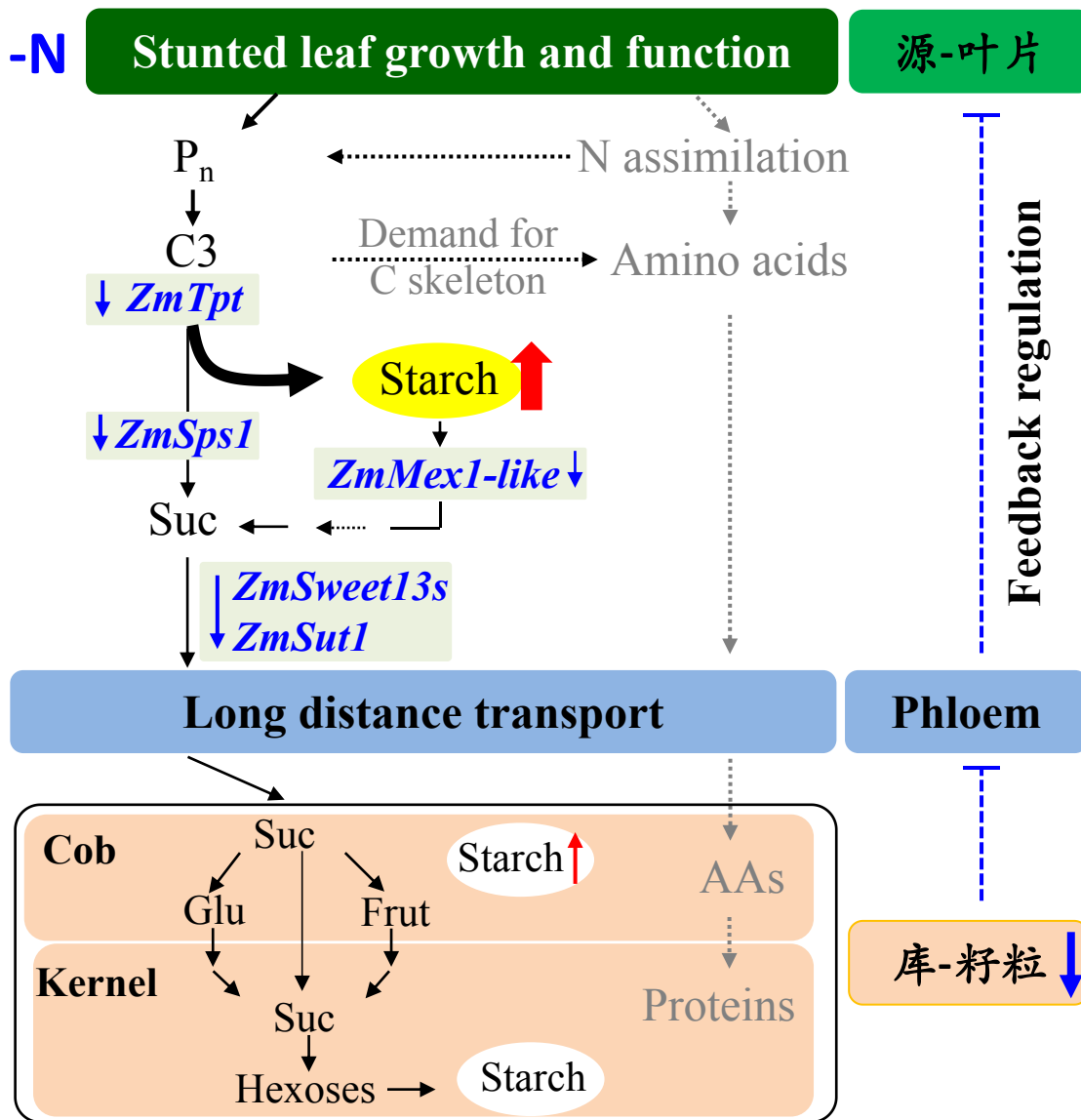
低氮导致玉米穗轴中糖类和淀粉累积



籽粒中糖类和淀粉的累积



总结



Take-home message:

低氮玉米叶片蔗糖输出的共质体途径正常，但韧皮部装载过程明显受到限制；

同时，低氮导致籽粒碳利用能力降低，进一步反馈抑制叶片中蔗糖输出，最终影响产量。



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谢谢大家！
敬请批评指正！

宁鹏

西北农林科技大学·资源环境学院

ningp@nwafu.edu.cn

低氮玉米穗长、籽粒数目和粒重降低

