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Potassium deficiency limits reproductive success by altering carbohydrate and protein balances in cotton (*Gossypium hirsutum* L.)

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Highlights

- K deficiency limited the sucrose and amino acids translocation to the pistils.
- K deficiency decreased markedly carbohydrate and protein metabolism in pistils.
- K deficiency decreased pollen tube growth and fertilization efficiency.
- Low reproductive success was related to the changes in pistils biochemistry under K deficiency.

Abstract: Reproductive success in higher plants requires a lot of energy and substance provided by carbohydrate and protein metabolism，and potassium (K) plays an important role in carbohydrate and protein metabolism. However, it is unclear whether K deficiency limits reproductive success by disturbing carbohydrate and protein metabolism. The objectives of this study were to explore the effects of K deficiency on carbohydrate and protein metabolism in subtending leaves, phloem and pistils, and their relationship with reproductive success. A cotton cultivar DP0912 was grown in K-deficient (0 mM K^+) and K-sufficient (6 mM K^+) nutrient solution in growth chambers. Results showed that *Pn* of the subtending leaves was decreased under K deficiency, but sucrose, starch and free amino acid contents were markedly increased in the K-deficient leaves, because K deficiency limited the translocation of sucrose and amino acid in phloem. As a result, sucrose and free amino acid contents were reduced by 47.3% and 51.8% in the K-deficient pistils than K-sufficient pistils, which led to further decreases in starch and protein accumulation in the K-deficient pistils. Glucose content was also reduced by 53.1% in the K-deficient pistils than K-sufficient pistils, due to the decreased acid and alkaline invertase activities, since sucrose synthase activity was not affected. Lastly, soluble carbohydrate and ATP contents were lower in the K-deficient pistils than K-sufficient pistils, similarly to the changes of pollen tube growth rate and seed set efficiency. It was concluded that the lower carbohydrate and ATP contents in the K-deficient pistils could not meet the energy requirements of pollen tube growth and seed set. Moreover, protein imbalance also limited pollen tube growth. Those changes