Revisiting yield in terms of phloem transport to grains suggests phloem sap movement might be homeostatic in wheat

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Abstract

Phloem sap transport, velocity and allocation have been proposed to play a role in physiological limitations of crop yield, along with photosynthetic activity or water use efficiency. Although there is clear evidence that carbon allocation to grains effectively drives yield in cereals like wheat (as reflected by the harvest index), the influence of phloem transport rate and velocity is less clear. Here, we took advantage of previously published data on yield, respiration, carbon isotope composition, nitrogen content and water consumption in winter wheat cultivars grown across several sites with or without irrigation, to express grain production in terms of phloem sucrose transport and compare with xylem water transport. Our results suggest that phloem sucrose transport rate follows the same relationship with phloem N transport regardless of irrigation conditions and cultivars, and seems to depend mostly on grain weight (i.e. mg per grain). When compared to xylem sap water movement, phloem sap velocity (in m s^{-1}) was 5.8 to 7.7 times lower. Depending on the assumption made for phloem sap sucrose concentration, either phloem sap velocity or its proportionality coefficient to xylem velocity change little with environmental conditions. Taken as a whole, phloem transport from leaves to grains seems to be homeostatic within a narrow range of values and following relationships with other plant physiological parameters across cultivars and conditions. This suggests that phloem transport per se is not a limitation for yield in wheat but rather, is controlled to sustain grain filling.

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