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Early establishment of photosynthesis plays a key role in early biomass heterosis in Brassica napus (canola) hybrids

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Heterosis or hybrid vigour has been used for decades in canola production. Canola hybrids show heterosis in a variety of traits compared to parents, including increased biomass at early stages of seedling establishment, which is a critical developmental step that impacts future plant growth and seed yield. However, the mechanism of biomass heterosis at early seedling stages is still not well understood. In this study, we examined transcriptomes of two parental lines, Garnet (Gar) and NX0052 (0052), and their reciprocal hybrids, Gar/0052, at 4 and 8 days after sowing (DAS). We found that early seedling biomass heterosis is correlated with up-regulated gene expression levels in photosynthesis pathways at 4 DAS in hybrids relative to parents, which could be due to early activation of these genes in the hybrids. In addition to transcriptional changes, the hybrids also begin photosynthesis earlier than the parental lines. Auxin is a key phyto-hormone that regulates plant development through promoting cell expansion and cell proliferation. As a downstream pathway of photosynthesis, the auxin biosynthesis pathway showed up-regulated gene expression levels in hybrids, which is consistent with higher auxin concentrations detected in hybrid seedlings at 4 DAS. Consistent with increased levels of auxin, hybrids have larger and more palisade cells than the parents at the same time point. Based on the above findings, we propose a possible mechanism of early heterosis through early establishment of photosynthesis and auxin production, resulting in early seedling biomass heterosis in the hybrids due to the advantages in cell size and cell number. This finding could be utilized in future canola breeding to identify hybrid lines with superior early seedling establishment.