

## Antioxidants

Article

# Antioxidative and Metabolic Contribution to Salinity Stress Responses in Two Rapeseed Cultivars during the Early Seedling Stage

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**Abstract:** Measuring metabolite patterns and antioxidant ability is vital to understanding the physiological and molecular responses of plants under salinity. A morphological analysis of five rapeseed cultivars showed that Yangyou 9 and Zhongshuang 11 were the most salt-tolerant and -sensitive, respectively. In Yangyou 9, the reactive oxygen species (ROS) level and malondialdehyde (MDA) content were minimized by the activation of antioxidant enzymes such as superoxide dismutase (SOD), peroxidase (POD), catalase (CAT), and ascorbate peroxidase (APX) for scavenging of overaccumulated ROS under salinity stress. Furthermore, Yangyou 9 showed a significantly higher positive correlation with photosynthetic pigments, osmolyte accumulation, and an adjusted Na<sup>+</sup>/K<sup>+</sup> ratio to improve salt tolerance compared to Zhongshuang 11. Out of 332 compounds identified in the metabolic profile, 225 metabolites were filtrated according to  $p < 0.05$ , and 47 metabolites responded to salt stress within tolerant and sensitive cultivars during the studied time, whereas 16 and 9 metabolic compounds accumulated during 12 and 24 h, respectively, in Yangyou 9 after being sown in salt treatment, including fatty acids, amino acids, and flavonoids. These metabolites are relevant to metabolic pathways (amino acid, sucrose, flavonoid metabolism, and tricarboxylic acid cycle (TCA), which accumulated as a response to salinity stress. Thus, Yangyou 9, as a tolerant cultivar, showed improved antioxidant enzyme activity and higher metabolite accumulation, which enhances its tolerance against salinity. This work aids in elucidating the essential cellular metabolic changes in response to salt stress in rapeseed cultivars during seed germination. Meanwhile, the identified metabolites can act as biomarkers to characterize plant performance in breeding programs under salt stress. This comprehensive study of the metabolomics and antioxidant activities of *Brassica napus* L. during the early seedling stage is of great reference value for plant breeders to develop salt-tolerant rapeseed cultivars.

**Keywords:** *Brassica napus*; salinity stress; antioxidant enzymes; osmolytes; ROS; metabolites