agronomy

Article

Stomata and Xylem Vessels Traits Improved by Melatonin Application Contribute to Enhancing Salt Tolerance and Fatty Acid Composition of *Brassica napus* L. Plants

Ibrahim A. A. Mohamed [1,2], Nesma Shalby [2,3], Ali M. A. El-Badri [1,4], Muhammad Hamzah Saleem [1], Mohammad Nauman Khan [1], Muhammad A. Nawaz [5], Meng Qin [1], Ramadan A. Agami [2], Jie Kuai [1], Bo Wang [1] and Guangsheng Zhou [1,*]

[1] MOA Key Laboratory of Crop Ecophysiology and Farming System in the Middle Reaches of the Yangtze River, College of Plant Science and Technology, Huazhong Agricultural University, Wuhan 430070, China; iaa04@fayoum.edu.eg (I.A.A.M.); alyelbadry@webmail.hzau.edu.cn (A.M.A.E.-B.); saleemhamza312@webmail.hzau.edu.cn (M.H.S.); naumanagrarian@yahoo.com (M.N.K.); qmm1713@webmail.hzau.edu.cn (M.Q.); kuaijie@mail.hzau.edu.cn (J.K.); wangbo@mail.hzau.edu.cn (B.W.)

[2] Faculty of Agriculture, Fayoum University, Fayoum 63514, Egypt; nas05@fayoum.edu.eg (N.S.); ramadanagami@yahoo.com (R.A.A.)

[3] College of Plant Science and Technology, Huazhong Agricultural University, Wuhan 430070, China

[4] Rice Research and Training Center, Field Crops Research Institute, Agriculture Research Center, Kafrelsheikh 33717, Egypt

[5] College of Agriculture, University of Sargodha, Sargodha 40100, Pakistan; azher490@hotmail.com

***** Correspondence: zhougs@mail.hzau.edu.cn; Tel.:+86-186-2794-5966

Received: 9 July 2020; Accepted: 10 August 2020; Published: 13 August 2020

Abstract: Salinity stress is a limiting factor for the growth and yield quality of rapeseed. The potentiality of melatonin (MT; 0, 25, 50, and 100 μM) application as a seed priming agent in mediating K^+/Na^+ homeostasis and preventing the salinity stress mediated oxidative damage and photosynthetic inhibition was studied in two rapeseed cultivars. We found that 50 μM MT treatment imparted a very prominent impact on growth, metabolism of antioxidants, photosynthesis, osmolytes, secondary metabolites, yield, and fatty acids composition. Days required for appearance of first flower and 50% flowering were decreased by MT application. Exogenous MT treatment effectively decreased the oxidative damage by significantly declining the generation of superoxide and hydrogen peroxide under saline and non-saline conditions, as reflected in lowered lipid peroxidation, heightened membrane stability, and up-regulation of antioxidant enzymes (catalase, superoxide dismutase, and ascorbate peroxidase). Furthermore, MT application enhanced the chlorophyll content, photosynthetic rate, relative water content, K^+/Na^+ homeostasis, soluble sugars, and proline content. Moreover, MT application obviously improved the oil quality of rapeseed cultivars by reducing glucosinolates, saturated fatty acids (palmitic and arachidic acids), and enhancing unsaturated fatty acids (linolenic and oleic acids except erucic acid were reduced). Yield related-traits such as silique traits, seed yield per plant, 1000 seeds weight, seed oil content, and yield biomass traits were enhanced by MT application. The anatomical analysis of leaf and stem showed that stomatal and xylem vessels traits are associated with sodium chloride tolerance, yield, and seed fatty acid composition. These results suggest the supportive role of MT on the quality and quantity of rapeseed oil yield.

Keywords: rapeseed; salinity stress; N-acetyl-5-methoxytryptamine; seed oil quality; antioxidant system; microstructure