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Biostimulant Activity of Chitooligomers: Effect of Different Degrees of Acetylation and Polymerization on Wheat Seedlings under Salt Stress

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Abstract : Salt stress is one of the most serious abiotic stresses, and it can lead to the reduction of agricultural productivity. High salt concentration makes it more difficult for roots to absorb water and disturbs the homeostasis of cellular ions resulting in osmotic stress, ion toxicity and generation of reactive oxygen species (ROS). Compared with the normal physiological conditions, salt stress could inhibit the photosynthesis, break metabolic balance and damage cellular structures, and ultimately results in the reduction of crop yield. Therefore it is vital to develop practical methods for improving the salt tolerance of plants. Chitooligomers (COS) is partially depolymerized products of chitosan, which is consisted of D-glucosamine and N-acetyl-D-glucosamine. In agriculture, COS has the ability to promote plant growth and induce plant innate immunity. The bioactivity of COS closely related to its degree of polymerization (DP) and acetylation (DA). However, most of the previous reports fail to mention the function of COS with different DP and DAs in improving the capacity of plants against salt stress. Accordingly, in this study, chitooligomers (COS) with different degrees of DAs were used to test wheat seedlings response to salt stress. In addition, the determined degrees of polymerization (DPs) COS(DP 4-12) and a heterogeneous COS mixture were applied to explore the relationship between the DP of COSs and its effect on the growth of wheat seedlings in response to salt stress. It showed that COSs, the exogenous elicitor, could promote the growth of wheat seedling, reduce the malondialdehyde (MDA) concentration, and increase the activities of antioxidant enzymes. The results of mRNA expression level test for salt stress-responsive genes indicated that COS keep plants away from being hurt by the salt stress via the regulation of the concentration and the increased antioxidant enzymes activities. Moreover, it was found that the activities of COS was closely related to its Das and COS (DA: 50%) displayed the best salt resistance activity to wheat seedlings. The results also showed that COS with different DP could promote the growth of wheat seedlings under salt stress. COS with a DP (6-8) showed better activities than the other tested samples, implied its activity had a close relationship with its DP. After treatment with chitohexaose, chitoheptaose, and chitooctaose, the photosynthetic parameters were improved obviously. The soluble sugar and proline contents were improved by 26.7%-53.3% and 43.6.0%-70.2%, respectively, while the concentration of malondialdehyde (MDA) was reduced by 36.8% - 49.6%. In addition, the antioxidant enzymes activities were clearly activated. At the molecular level, the results revealed that they could obviously induce the expression of Na+/H+ antiporter genes. In general, these results were fundamental to the study of action mechanism of COS on promoting plant growth under salt stress and the preparation of plant growth regulator.

Keywords : chitooligomers (COS), degree of polymerization (DP), degree of acetylation (DA), salt stress
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