Biogenic zinc oxide nanoparticles protect tomato plants against *Pseudomonas syringae* pv. tomato, the casual agent of bacterial speck disease

The control of bacterial plant diseases is very challenging and often relies on the application of copper compounds, although the frequent emergence and spread of resistant bacterial strains compromise their efficacy. Additionally, copper-based compounds raise environmental and human health concerns, leading to their inclusion in the European Commission's list of candidates for substitution. As a promising and sustainable alternative, we investigated the efficacy of biogenic zinc oxide nanoparticles (ZnONPs) in protecting tomato plants against *Pseudomonas syringae* pv. tomato (Pst), the causal agent of bacterial speck disease. ZnONPs exhibited significant *in vitro* antibacterial activity (EC_{95} = 17.0 ± 1.1 ppm) against the pathogen. Furthermore, when applied to the foliage of tomato plants at 100 ppm before or following Pst inoculation, they induced significant reductions in symptom severity and bacterial growth *in planta*, which were comparable to those shown by plants treated with acibenzolar-S-methyl, a plant defense inducer. Gene expression assessed by qPCR revealed the involvement of the systemic acquired resistance (SAR) pathway in tomato plants treated with ZnONPs before inoculation, suggesting that the observed protection could be due to a priming effect. Finally, infected plants showed oxidative stress, with higher H_2O_2 and malondialdehyde (MDA) contents. ZnONPs reverted this effect, containing the content of the above molecules, and stimulated the production of metabolites involved in dealing with oxidative perturbations (carotenoids and phenols), while unaffecting flavonoids and anthocyanins.