Enhancing Wheat (Triticum aestivum L.) Growth Through Uptake and Translocation of Iron (III) Oxide (Fe_2O_3) Nanomaterials

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Global population growth has dramatically increased in the last century. Recent studies state that food production must be doubled to meet the global demand. Nanomaterials (NMs) are used in disciplines such as material sciences, biomedicine, biotechnology, and agriculture. The size of the NMs is a critical factor that affects their integration and transfer into the biological systems. This study aims at investigating the effect of different-sized NMs on i) plant growth and physiology, and ii) NMs-uptake and translocation in plant tissues. For these purposes, iron (III) oxide (Fe_2O_3) NMs with size of 8-10, 20-40, and 30-50 nm, have been subjected to wheat plants (n = 10) in a hydroponic system. Results showed all Fe_2O_3 NMs enhanced root length, plant height, biomass, and chlorophyll content of wheat. Confocal microscopy analysis indicated Fe_2O_3 NMs cause injury in root-tip cells without a visible toxic symptom. Vibrating sample magnetometer (VSM), and inductively coupled plasma-mass spectroscopy (ICP-MS) analyses of leaf tissues revealed all tested NMs were up taken by wheat plants and translocated to the leaves. Iron content was found to be dramatically increased in NMs-treated plant tissues, which possibly contributed to growth enhancement. Experiments confirmed that Fe_2O_3 NMs with 20-40 nm size are much more efficient in plant growth, compared to those with 8-10 and 30-50 nm size. Light reflection capability and dissociated iron ions may contribute to the wheat growth by enhancing photosynthesis machinery. Overall, Fe_2O_3 NMs with 20-40 nm in size could be proposed as an effective nano-fertilizer for agricultural applications.