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Synthesis and Characterization of Copper Oxide Nanoparticles and Its Influence on Pearl Millet (Pennisetum Gluacum L.) Under Drought Conditions

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Abstract

Nanoparticles have been shown to alleviate drought stress by improving morphological, physio-biochemical parameters, and subsequently enhance agricultural productivity in recent years. Due to industrialization and other man-made activities, there has been a tremendous impact on our environment leading to severe repercussions of climate change. There has been a huge debate on how this climate change will impact the crop production and agriculture. Pearl millet, one of the important super foods, has both drought-tolerant and -sensitive varieties. The aim of the study is to synthesize and characterize copper oxide nanoparticles and study their role in improving crop productivity in pearl millet varieties exposed to drought stress. The Bovine Serum Albumin (BSA)-capped copper oxide (CuO) nanoparticles were synthesized using wet chemical method [1]. The nanoparticles were characterized using Dynamic Light Scattering (DLS) particle size analyser, UV-Vis spectrophotometer, X-ray diffraction analysis (XRD), High Resolution-Field Emission Scanning Electron Microscopy (HR-FESEM) [2], Energy-dispersive X-ray spectroscopy (EDX), and Fourier transformed infrared spectroscopy (FTIR) [1]. We synthesised stable copper oxide nanoparticles (confirmed with EDX spectra) of average hydrodynamic diameter of 78.33 ±17.0 nm, Polydisperse index of 0.191 and zeta potential of -29.5 ±4.18 mV. The average particle size of 29.33 nm was noted using ImageJ analysis. The crystallinity of the copper oxide nanoparticles was confirmed by XRD characterization. The FTIR spectra revealed characteristic peaks attributable to the stretching vibration of the O-H and N-H groups of the amino group of BSA and carboxyl group of ascorbic acid. BSA was used to cap the synthesized particles and to avoid aggregation of nanoparticles and the precursor salt was reduced by ascorbic acid. The synthesised copper oxide nanoparticles were used to treat pearl millet seeds at different concentrations of 0, 100, 200 and 300 ppm. The control and treated seeds were inoculated on Murashige and Skoog (MS) media supplemented with various concentrations of polyethylene glycol (1%, 5%, 10%) for drought induction [4]. CuO nanoparticles enhanced the germination rate of the pearl millet seeds. The biomass and the morphological features were improved in treated seeds. The pigment analysis showed that nanoparticle treatment (300 ppm) exhibited higher Chlorophyll a and b and carotenoid contents at moderate (5%) and severe (10%) drought conditions. This study could help in the development of cost effective and environment-friendly nano-mediated treatment for crops under drought stress. The detailed methods and results of morphological and biochemical characters will be presented and discussed.

Keywords: Copper oxide nanoparticles, Characterization, Pearl millet, Drought stress, Biomass, Chlorophyll, and carotenoid.

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