Abstract

Nano-Biopesticides Development Using Cow Dung and Cow Urine against *Oligonychus coffeae* Nietner

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The red spider mite or *Oligonychus coffeae* Nietner is a significant pest of tea (*Camellia sinesis* L.) in the majority of tea-producing nations. In Northeast India, it is among the most devastating pests that affect tea plants. At the moment, synthetic acaricides are used to control the pest. Excessive use of which causes a variety of problems, including pesticide resistance, impact on species not intended to be affected, environmental pollution, and residues in tea. Alternative pest management techniques are thus being used more frequently; however, the continued use of synthetic pesticides on food and beverage crops is raising concerns around the globe due to their possible impacts on human health and the environment. A promising approach for controlling several pests has been made possible by recent advancements in nanotechnology. In the current work, biological synthesis of zinc oxide nanoparticles and iron oxide nanoparticles using cow urine and cow dung extract and acaricidal effect on *O. coffeae* was reported. UV-vis spectroscopy, Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), and energy dispersive X-ray (EDX) analysis were used to bio-physically characterize the biosynthesized iron oxide nanoparticles and zinc oxide nanoparticles using extract of cow dung and cow urine. An absorption peak at 410 nm was observed in the UV-Vis spectra of cow dung-mediated zinc oxide nanoparticles, whereas an absorption peak at 365 nm was observed in the cow urine-mediated zinc oxide nanoparticles. UV-Vis spectral analysis revealed an absorption peak at 290 nm, and 293 nm for cow dung extract and cow urine-mediated zinc oxide nanoparticles.

The biophysical characterization of the synthesized zinc oxide nanoparticles using cow dung extract had rod structures with particle sizes ranging from 44 nm to 60 nm, while synthesized zinc oxide nanoparticles using cow urine have spherical structures with diameters ranging from 24 nm to 40 nm. Iron oxide nanoparticles synthesized using cow dung extract and cow urine were spherical in shape, with particle sizes ranging from 50 nm to 55 nm and 46.5 nm and 73.5 nm, respectively. The experiments carried out under laboratory and field conditions significantly enhanced the efficacy of biologically synthesized zinc oxide nanoparticles and iron oxide nanoparticles using cow urine and cow dung extract. Using the leaf dip and spray method, the acaricidal effect of biologically synthesized zinc oxide and iron oxide nanoparticles at different concentrations of 100 ppm, 250 ppm, 500 ppm, 750 ppm, and 1000 ppm, was tested against *O. coffeae* at various stages (adults, nymphs, and eggs) at the laboratory. The mortality percentage was calculated with different concentrations of nanoparticles. The mortality was observed to be dose-dependent and time-dependent, i.e., increases with an increase in the concentration of nanoparticles. The mortality of 71.67 % and 86.67 % against cow dung-mediated zinc oxide nanoparticles, 83.33 % and 98.33 % against cow urine-mediated zinc oxide nanoparticles, 63.33 % and 93.33 % against cow dung mediated iron oxide nanoparticles, and, 93.33 % and 96.67 % against cow urine mediated iron oxide nanoparticles was observed for adults and nymphs of *O. coffeae* at 1000 ppm for the leaf dip and spray method. The ovicidal activity was observed to be 61.11% and 64.44% for cow dung-mediated zinc oxide nanoparticles, 95 % and 96.67 % for cow urine-mediated zinc oxide nanoparticles, 66.67 % and 70 % for cow dung-mediated iron oxide nanoparticles, and 51.67 % and 98.33 % for cow urine-mediated iron oxide nanoparticles on eggs of *O. coffeae* at 1000 ppm for the leaf dip and spray method. Deposition of eggs by adult mites on treated leaf surfaces decreased significantly, and the viability of eggs was also significantly reduced. Field bio-efficacy results indicated that the cow

dung-mediated zinc oxide and iron oxide nanoparticles and cow urine-mediated zinc oxide and iron oxide nanoparticles at 750 ppm and 1000 ppm concentrations were highly effective against *O. coffeae* and were superior to the commonly used pesticides like Azadirachtin 0.03% EC and Propargite 57% EC. Different dosages of the zinc oxide and iron oxide nanoparticle solution and cow urine-mediated zinc oxide and iron oxide nanoparticle solution were sprayed onto tea bushes, but no phytotoxic effects were observed. The appearance of liquor, flavour, and taste of black tea manufactured from tea shoots treated with these solutions was unaffected by the treatments, and the tea was free from any taint. Further, the cow dung-mediated zinc oxide and iron oxide nanoparticle solution and cow urine-mediated zinc oxide and iron oxide nanoparticle solution had no significant effect on nontarget natural enemies and soil microbiota. Cow dung and cow urine-mediated zinc oxide and iron oxide nanoparticles showed no significant antibacterial effects against *Escherichia coli, Bacillus paranthracis, and Bacillus thuringiensis*. The current biosynthesis procedure of cow dung and cow urine-mediated zinc oxide and iron oxide nanoparticles is a novel, affordable, cheap, and easy method that is perfect for large-scale commercial production. This study concludes that cow dung-mediated zinc oxide and iron oxide, as well as cow urine-mediated zinc oxide and iron oxide nanoparticles, are both efficient against *O. coffeae* and may be employed as a substitute pest control agent in the future to manage tea pests.