BENEFICIAL ROLE OF ZINC OXIDE NANOPARTICLES ON GREEN CROP PRODUCTION

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ABSTRACT

Impairment of the visibility involves degrading of the ability to perceive the environment. The size of particles plays a crucial role for the interaction with light, but so far the existent links between visibility impairment and mass concentrations have been established for larger particles. Shape and composition of particles are also relevant for visibility reduction. Therefore, deeper understanding of nanoparticles role in visibility impairment is necessary. The engineered nanoparticles are incorporated into many products of daily use (agriculture, pharmaceuticals, lubricants, cosmetics, catalysts, electronic devices and other domestic appliances). Nowadays an increasing application of nanotechnology in graded fields has an extensive debate about the effect the nanoparticles on environment. However very few studies have been done so far on the beneficial aspects of nanoparticles on green crop plants. In this article, we report the beneficial effect of zinc oxide nanoparticles having diameter of 20nm on (Vigna radiata L.) seeds, which has been characterized by XRD, PSA, FTIR, SEM and TG-DTA. The measurements of germination percentage, biomass, shoot and root growth were noted down using with and without nanoparticles.

Key words: Environment, characterization, germination, plant growth, nanoparticles.

Introduction:

Nanotechnology is the term given to those areas of science and engineering where phenomena that take place at dimensions in the nanometer scale are utilized in the design, characterization, production and application of materials, structures, devices and systems '(Shailesh K, 2013 et al.)'. Nano technology is one of the most rapidly progressing fields of technology and it has opened up numerous new frontiers of research for us.

Its advent into the field targeted drug delivery, agriculture and as bio sensors '(P.Yugandhar, 2013 et al.)'. Various biological and chemical methods are being devised to from new nanoparticles with more specifications, like shape, size, specificity and other characteristics of the particles more closely. '(Hediat M.H, 2012 et al.)' One of the most useful and revolutionary technique coming up presently is synthesis of nanoparticles using plant extracts. The formation of nanoparticles using plant extracts has a major edge over methods in terms of its interaction and effect on the environment. The engineering nanomaterial usage has increased over years in various fields namely medicine, cosmetics, toys, other consumer products, etc '(Harris, A.T, 2008 et al)'. They have versatile properties such as self-assembly, specificity, encapsulation, stability, and biocompatibility. Among the available nanomaterials, Zinc oxide nanoparticles (ZnO NPs) form a major part of the medical and agricultural industry due to their possession of antimicrobial activity. '(Linga Rao, 2012 et al.)' In particular, zinc oxide NPs have been widely exploited for their photolytic properties and are finding extensive application in personal care products because of their ultraviolet-blocking ability.'(Hossein, 2013 et al.)' This present work reports an ecofriendly approach for the synthesis of Zinc oxide nanoparticles (ZnO NPs)using aqueous *C. longa* tubers extract to be responsible for the bio-reduction of ZnO NPs. The formed ZnO NPs were characterized by XRD, FTIR, PSA, TG/TDA and SEM analysis.The current study is therefore, aimed at investigating the direct influence of nano- zinc oxide feeding on the growth and development of plant.

Experimental Details:

a) Materials

Curcurm longa tubers (from local market), zinc acetate, acetone, ethanol, and distilled water were used in the synthesis process in their pure form without any further modification.

b) Preparation of curcuma longa tubers extract powder

The *C. longa* tubers were collected from local market, Hyderabad. The *C. longa* tubers were washed to remove the adhering mud particles and possible impurities. Later they were dried under sunlight for a week to completely remove the moisture. The dry tubers were cut into small pieces, powdered in a mixer, and then sieved using a 20-mesh sieve to get uniform size range. The final sieved powder was used for all further studies. For the production of extract, 0.5 g of *C. longa* tubers powder was added to a 200 mL beaker with 100 mL ethanol and then this mixer stirring for 4 hours at 70^{O}C temperature. Then filter with Whatman filter paper.

c) Biological synthesis of ZnO nanoparticles

The ZnO nanoparticles were synthesized in biological method. The 0.5 M of zinc acetate was added in distilled water under constant stirring. The curcuma longa tubers powder extraction was introduced to above solution in 40 ml, this was then placed in a magnetic stirrer for 3 hrs at 80^{o}C temperature. The resultant solution was placed in hot plate the evaporation of water. Then collected sample material calcined for 2hrs at 400^{0}C.

c) Seeds

The mung bean seeds were purchased from market these seeds were kept in a dry place in the dark under the room temperature before using.

d) Seedling exposure

The seeds were checked for their viability by suspending them in double distilled water. The seeds which are settled to the bottom were selected for further study. The seeds were rinsed in double distilled water thrice and then surface sterilization of seeds was done. The biological synthesized ZnO, nanoparticles were sonicated for 3 hrs. Then add the sterilized seeds in prepared nanoparticle suspensions (graded concentrations) using a sonicator instrument. The soaked seeds were put in prepared pots and observe the growth parameters of mung bean plant.

e) Percentage of Seed germination

Seed germination (%) = (Number of germinated seeds/ Number of total seeds) ×100

Results and Discussions:

a) X-ray diffraction (XRD) analysis

From the Figure 1. Shows the XRD patterns of ZnO nanoparticles. The sharp intense peaks of ZnO confirms the good crystalline nature of ZnO and the peaks originated from 31.7^{o} (100), 34.5^{o} (002), 36.2^{o} (101), 47.7^{o} (102), 56.6^{o} (110), 62.2^{o} (103), 68.4^{o} (112).Average crystallite size of ZnO was 14.6 nm estimated according to the Scherrer's equation as follows the Equation.

$$D = K\lambda/\beta\cos\theta$$

K is the Scherer constant, λ the X-ray wavelength, β, the peak width of half maximum, and θ is the Bragg diffraction angle.

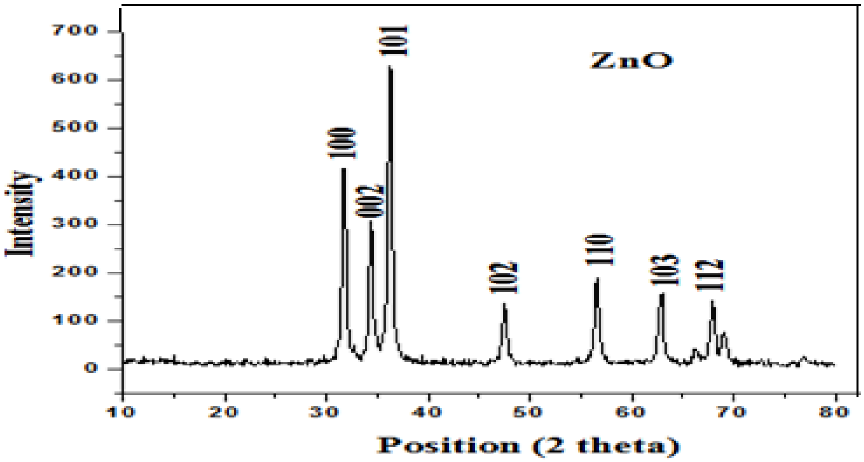

Figure 1. XRD pattern of ZnO nanoparticles

b) FTIR analysis

From the 'Figure 3', FT-IR spectrum of the synthesized ZnO nanoparticles shown the fundamental mode of vibration at 3457.5.3 are may be due to O-H stretching and deformation, respectively assigned to the water adsorption on the metal surface, 2923.4, 2853.4 which corresponds to C-H stretching vibration. The 1383.9 and 1322.1corresponds to C=O asymmetric C=O stretching vibration. 1634.6 corresponds to C=O symmetric stretching vibration. The absorption at 875 cm-1 is due to the formation of tetrahedral coordination of Zn. The bond at 1075 cm-1 is due to the C-O stretching vibration. The observed peaks in731.9 to 608.6 cm^{-1}indicates the stretching vibrations of ZnO nano particle.

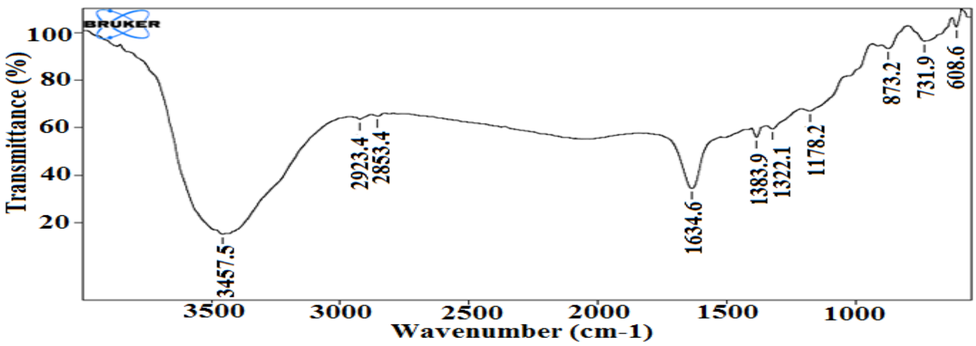

Figure 2. FTIR spectra of ZnO nanoparticles

c) Particle size analyser

Dynamic light scattering (DLS) which is based on the laser diffraction method with multiple scattering techniques was employed to study the average particle size of nanoparticles. The prepared sample was dispersed in deionized water followed by ultra-sonication. From the particle size analyzer we have obtained average (mean) particle size, standard deviation and most commonly found peak in the distribution as 32 nm. The bio combustion method is suitable to obtain the uniform distribution of the particles.

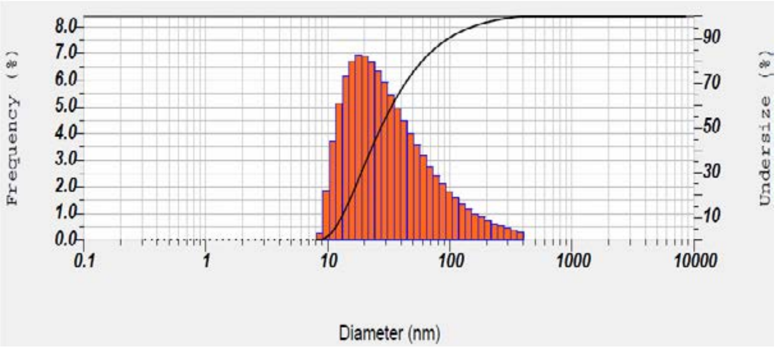

Figure 3.Particle distributions in the Dynamic Light Scattering

d) SEM analysis

The morphological features of synthesized nanoparticles from money plant extract were studied by Scanning Electron Microscope. ZnO nanoparticles are homogeneous distribution and agglomeration of particles was observed.

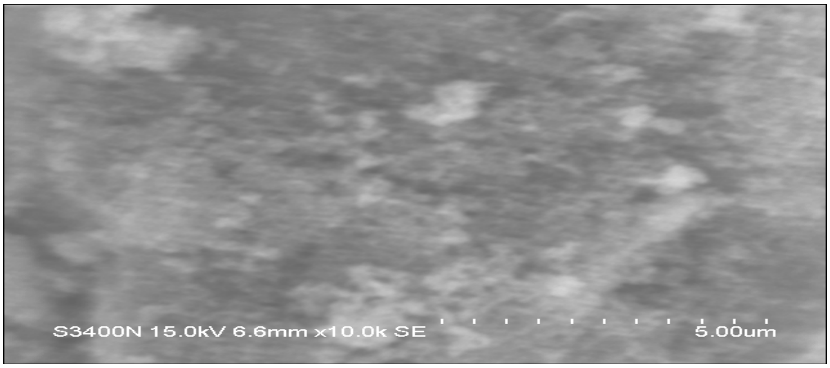

Figure 4. SEM image of ZnO nanoparticles

Figure 5. Different concentrations of MgO NPs on Mungbean seed germination

Table 1. Germination test

ZnO nanoparticles	Germination percentage
Control	80
50mg	95
100mg	95
150mg	90

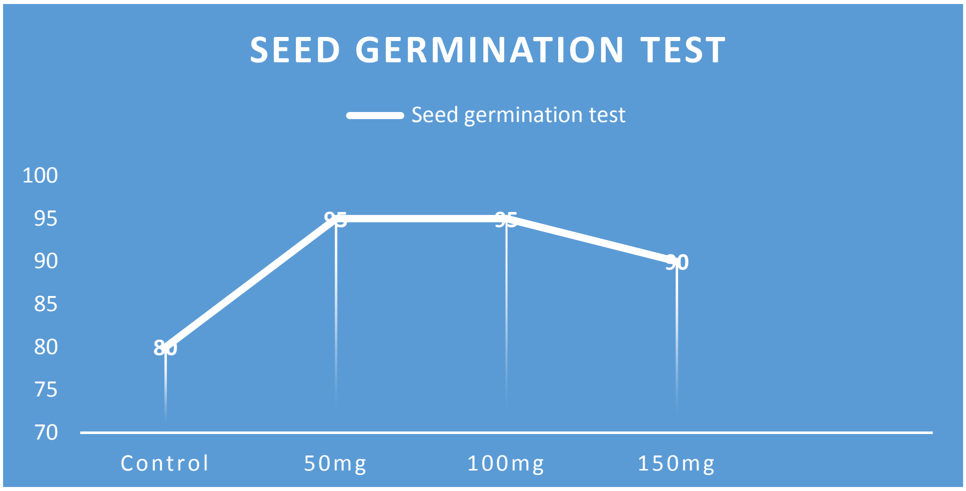

Figure 6. Effect of ZnO NPs on seed germination of mungbean

Table2. Mungbean seed germination and measurement of growth parameterswithin 20days

	Biomass weight	**Shoot length**	**Root length**	**Shoot weight**	**Root weight**
Control	0.459	20.2	7.3	0.297	0.021
50mg	0.540	22.6	9.1	0.326	0.022.8
100mg	0.539	23	9.1	0.334	0.023.1
150mg	0.534	21.5	9.6	0.321	0. 022.2

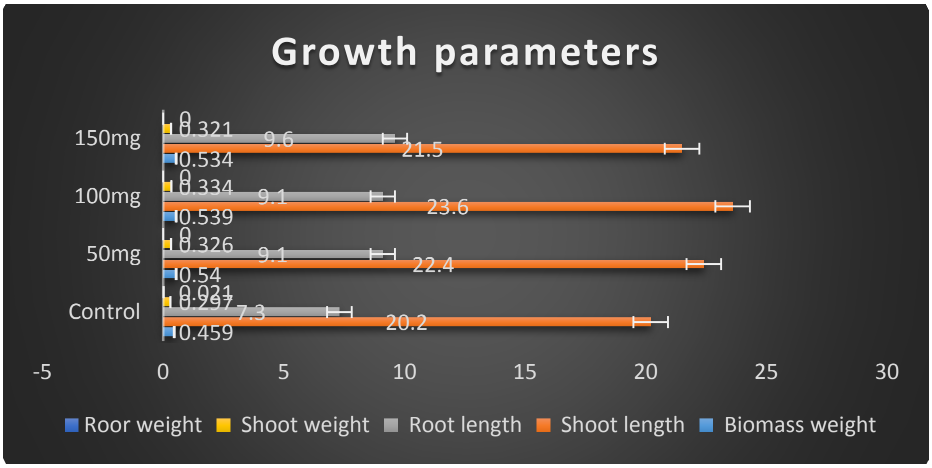

Figure 7. Effect of ZnO NPson seed germination and growth parameters of Mungbean

Evaluation of germination and growth parameters using biosynthesized ZnO nanoparticles treatments:

The plantextract containing secondary metabolites and some other compounds both act as a reducing as well as stabilizing agent. Plant extract for the formation of nanoparticles is being favoured due to salubrious nature '(Liu XM, 2010 et al.)'. The green synthesized ZnO nanoparticles are environmental eco-friendly and easily dissolved in water compared to the chemically synthesized nanoparticles'(Shilpa Hiremath, 2013 et al.)'.The seed germination and seedling growth were affected by applied treatments (0.0, 50, 100 and 150mg). The ZnO NPs to mungbean roots is apparent from root length concentration is greatly involved with the soaking period also affects low concentration show promote on root length, shoot length and whole plant weight '(F.Hong,2005 et al.)'. Their results confirm that ZnO NPs may be accumulated in plant but may only moderately impact plant development.

Seedlings length and biomass were measured after a 10days growth in this nanoparticle suspension. The highest value of fresh weight was shown in 50 and 100mg and the lowest fresh weight was found in control. '(Navarro, E, 2008 et al.)' A significant positive influence on root and shoot elongation was observed in 50 and 100mg of ZnO NPs compared to those of unexposed control germination. Time of germination, percentage of germination, vegetative biomass shown results using 50 and 100mg concentration of ZnO NPs treated seeds as compared untreated '(Tapan Adhikari, 2012 et al.)'. The effects of the ZnO NPs on seedling growth and development of the germinated sprouts were studied. Root and shoot systems were well recognized as they were fully germination in treated experiments in less time as compared to control. Growth enhancement of ZnO NPs-treated plants may have been due to the major changes of morphological and well developed root system. Mungbean seeds were examined with three different concentrations (50,100 and 150 mg) of ZnO NPs and also without ZnO NPs. The treated and untreated seeds germinated at 10 day but percentage of germination was significantly higher in treated ZnO NPs suspension solution comparison to control. Suggested that 50 and 100mg concentration of ZnO NPs suspension solution was highly effective on the seed germination of mungbean when comparison to other concentrations and control. '(Gianquinto G, 2000 et al.)' Mungbean plant grown in 50 and 100mg possessed well developed long stems compared to control. A significance increase seed germination percentage, biomass shoot, root and dry weight (gm), shoot, root length (cm) of mungbean recoded at 50 and 100mg concentration of ZnO nanoparticles shown (table, 2). In this significance increase it may be due to the penetration of seed coat by ZnO nanoparticles. Indicate that ZnO NPs promote seed germination and seedling growth at 50 and 100mgconcentration, however at 150mg concentrations of ZnO NPs a significant decrease in seed germination was observed (table 1,)'(Sheykhbaglou R, 2010 et al)'. Our experiment observed two concentrations of ZnO NPs showed increase in percentage of seed germination over control was observed in 50, 100mg. The shoot, root length increased in all the concentration of ZnO NPs significant increase in shoot, root length over control was observed in 50, 100mg concentrations of ZnO NPs. The main reason in this experiment the 150mg concentration of ZnO NPs inhibit the root, shoot length when comparison to the control it may be inhibit growth of mungbean higher concentration of ZnO NPs.

Conclusion:

Environment ecofriendly synthesized zinc oxide nanoparticles effect on the mung bean seed germination, the graded concentration of zinc oxide nanoparticles. It penetrate easily inside the plant cell wall and causes effects on biomass and growth parameters of mung bean plant. Deposition of small size nanoparticles inside the cell wall and vacuoles causes disturbance in metabolic activity of plant. The effect can be minimizing by limiting the concentration of biological synthesized zinc oxide nanoparticles solution used in different activity. Mungbean *(V.radiata)* were economically important crop plant, nanoparticles can easily find their way in human body through food chain. More investigations are needed to determine the positive and negative impact of nanoparticles on crop plant and its consequences in other living organisms.

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