



## **Effects of zinc oxide nanoparticles on the physiology of two to four leaf stage hydroponically adapted seedlings of “*Vigna Radiata*”**

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### **ABSTRACT**

Nanotechnology is a branch of technological know-how which offers with the particle in nanoscale length stages among 10- hundred nanometers. Nanotechnology is gaining huge significance inside the field of electronics, strength, medicine, life sciences in reproductive technology and generation and agricultural sciences. Nanoparticles should reduce the harmful effect on non-goal plant tissue, in addition to on the surroundings. They may be used successfully as herbicides, Nano-pesticides, and Nano-fertilizers to increase plant manufacturing. But, Nano-ps impart toxicity to plant life, in addition to the surroundings, which cannot be omitted. Zinc oxide is type of an inorganic compound, which seems as a white in a colour powder & it's totally insoluble in water. It's far gift as zincite (zn) mineral within the earth's (crust of the earth) crust. As zinc & oxygen belong to institution II & VI of the periodic tabel desk, zinc oxide is also termed & known as a set of II-VI semiconductor. ZnO NanoPs have awesome residences so were implemented in various fields *Vigna radiata* commonly called mung bean, is an erect or semi- erect legume belonging to own family fabaceae. It's far in particular cultivated as meals crop in India, China, Korea, Asia and Africa. The crop is stated to be originated from var. sublobata which takes place during the regions of India and Burma. It's also grown at dried areas, at lower altitudes they are a particularly enriched with protein, calcium, phosphorous and nutrition A which makes them suitable as animal feed & human meals.

**Key words:** nanotechnology, *Vigna radiata*, semiconductor, Nano fertilizer, Zinc oxide.

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### **INTRODUCTION**

Nanotechnology is a (department of science) which deals with the particle in nanoscale length levels B/w 10-a hundred nanometers. Nanotechnology is gaining extensive significance inside the field of strength, electronics, and remedy, lifestyles sciences in reproductive science & era & agricultural sciences. Furthermore nanotechnology is used to transform wastes to strength thru enzymatic Nano-bioprocessing, as chemical sensors, in cleaning of water, disorder prevention, and treatment in flora the usage of numerous nanoparticles (1).

Nanoparticles are changed form of primary elements, they are small molecular aggregates of length no longer more than or less than 100 nm, which gather bizarre residences over their bulk material. Nanoparticles have better surface power, excessive catalytic efficiency, excessive floor-to-extent ratio, excessive catalytic efficiency, & sturdy adsorption capability (2). They have a completely unique residences which give a possibility to reap sustainable agriculture and at ease the destiny of upcoming agriculture and plenty of fields. They can be used as capability tool to increase the boom and yield of vegetation. Nanoparticles could reduce the harmful effect on non-goal vegetation tissue, as well as at the surroundings (3). They may be used correctly as herbicides, Nano-insecticides, & Nano-fertilizers and so on. To growth plant production. However, NPs impart toxicity to plant life, in addition to to the environment, which can't be left out. The toxicity of Nano-ps on plants depends on the size, shape, solubility, chemical composition, surface energy, and species. A better knowledge of the position of Nano-particles in flowers is essential for their sensible programs in improve crop productiveness. Nano-particles on the basis of their supply of foundation and synthesis, may be categorised into two type (a) natural and (b) Engineered NPs (4).

*Vigna radiata* typically known as mung bean, is an erect or semi-erect legume belonging to family fabaceae. It's far mainly cultivated as meals crop in India, China, Korea, Asia & Africa. The crop is said to be originated from var. sublobata which happens at some point of the regions of India & Burma. It is also grown at dried regions, at lower altitudes. It prospers quality in loamy soil. With nicely allotted rainfall of 70-90 cm. There are essential cultivars of *Vigna radiata* golden gram, which has yellow seeds & the pods often shatter at maturity, and inexperienced gram, which has inexperienced seeds and the pod ripening extra uniformly are less in all likelihood to shatter. *Vigna radiata* has a symbiotic courting with sure soil bacteria that shape nodules on the roots & restoration atmospheric nitrogen. In India, the seeds are boiled or sprouted & eaten as vegetable, in soups or as snacks and many others. The seeds are grinded to acquire flour which is utilized in sort of functions along with starch noodles, and biscuits and many others. they're an incredibly enriched with protein, calcium, phosphorous & diet A which makes them appropriate as animal feed in addition to human meals.

The seeds are stated to be a traditional supply of treatment plans for paralysis, coughs, rheumatism, fevers & liver ailments (5).

Specifically in photo catalytic applications, Nano-particles are extensively used to generate strength from photo electrochemical & electrochemical water splitting. Nano-ps additionally use in strength garage packages to reserve the energy into extraordinary bureaucracy at nanoscale stage.

## **MATERIAL AND METHODS (6-10)**

### **Seed germination and establishment of hydroponic culture**

**Requirements:** Viable mung bean seeds, Plastic pots (12 x 12cm), Petri plates, Hoagland medium, pH meter, mercuric chloride, laminar air flow.

#### **Procedure:**

*Vigna radiata* seeds were collected from the market. These seeds were store in an air tight container. Before use, the seeds were surface sterilized under Laminar air flow hood with 0.1% mercuric chloride (HgCl<sub>2</sub>) solution for 1-2 min to avoid fungal contamination & washed thoroughly three to four times with autoclaved distilled water to make it free from any traces of mercuric chloride in the seeds. These seeds were then germinated in autoclaved glass petri plate (10 cm) having autoclaved blotting paper imbibed with sterile deionized water (10–15 ml), at 25 °C in a BOD incubator under dark conditions with about 10-12 seeds in each petri dishes. After the germination within three days in dark, the petri dishes were transferred to light in thermos-statically culture room sustained at 25 ± 2 °C & 50% relative humidity. After one day of incubation in light in the above mentioned conditions, the germinated seeds were transferred to plastic container (12 x 12), for the establishment of hydroponics by selecting the uniformly germinated seedlings to grow in a 1000 ml of Hoagland's nutrient solution (pH 6.8 to 6.9, Elico LI 120 pH meter). These pots were kept in thermostatically controlled culture room maintained at 25 ± 2 °C & 50% relative humidity. The nutrient solution was bubbled with glass rod twice a day to avoid inadequate supply of oxygen, & also to avoid precipitation of salts. After every 3 days, the nutrient medium (Hoagland's) was replaced to avoid any nutrient deficiencies in the medium (figure 2).

### **Synthesis of nanoparticles**

#### **Preparation of Nanoparticles of metal compounds (11-13)**

##### **Chemical synthesis of zinc oxide Nanoparticles**

There are various methods for the chemical synthesis of zinc oxide (ZnO) nanoparticles.

Synthesis of nanoparticles using zinc nitrate (Zn (NO<sub>3</sub>)<sub>2</sub>).6H<sub>2</sub>O as principle raw reactant. It is a bottom-up approach of nanoparticle synthesis.

##### **Chemicals required**

Zinc nitrate hexahydrate (Zn (NO<sub>3</sub>)<sub>2</sub>).6H<sub>2</sub>O, Sodium hydroxide (NaOH), Ethanol (pure) (C<sub>2</sub>H<sub>5</sub>OH), Distilled Water.

##### **Instruments required**

Magnetic stirrer, Water bath, Sand bath, pH meter, Centrifuge, Spectrophotometer.

##### **Procedure**

Prepare the 10 ml solution of 0.45 M zinc nitrate hexahydrate {(Zn (NO<sub>3</sub>)<sub>2</sub>).6H<sub>2</sub>O} in distilled water & prepare 10ml 0.9 M sodium hydroxide (pH=12) in distilled water. Take the NaOH solution in separate beaker, and heat it up to 55 °C. Add zinc nitrate solution drop wise in NaOH solution. White turbidity will be appear in the mixture. Stir the mixture at 1000 rpm on magnetic stirrer for 2-3 hours. And filter the mixture using Whattmann filter paper no.1 Separate the precipitate & dry it on watch glass in sand bath for 5-7 minutes at 60°C. The resultant powder is washed in pure ethanol & kept overnight for drying. The prepared powdered zinc oxide was collected and weighed in weigh machine.

## RESULTS AND DISCUSSION

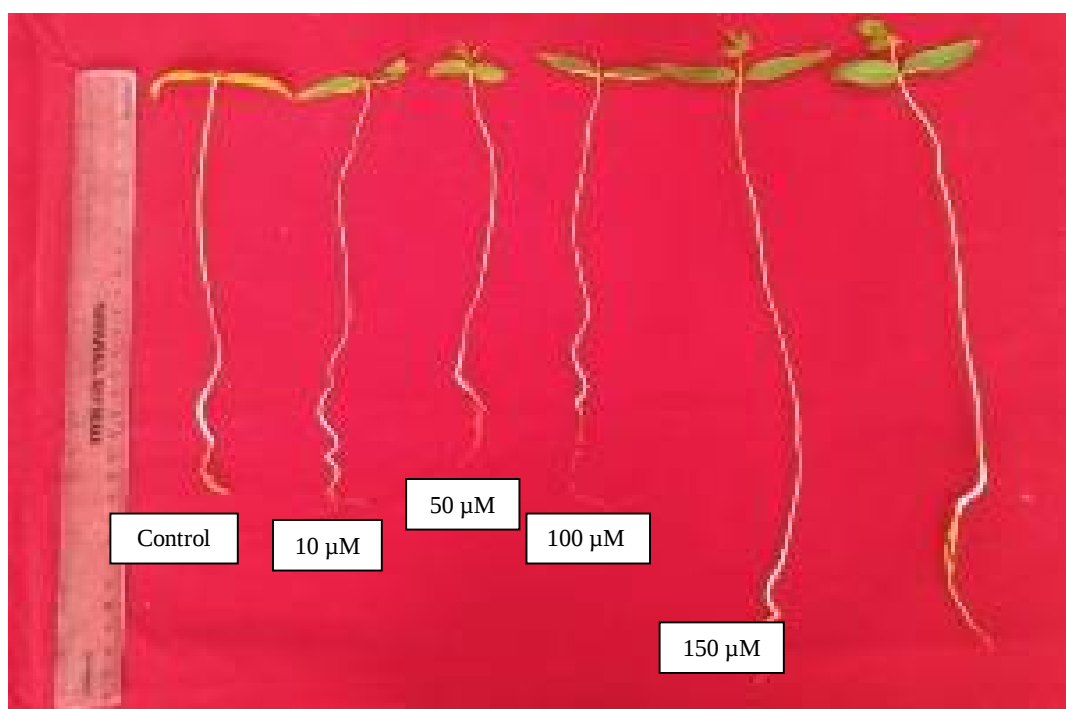
Growth parameter of two to four stage seedling of *Vigna radiata* was analysed by the measurement of root length, shoot length & number of leaves. As shown in table 1 decrease in root length & shoot length was noticed at 50  $\mu\text{M}$  concentration of ZnO NPs, but when the concentration of ZnO NPs is increased the increase in root length, shoot length & number of leaves was noticed. Maximum increase in root length & shoot length was noticed at 200  $\mu\text{M}$  ZnO concentration (table 2) (figure 1).

**Table: 1.** Composition of Hoagland Nutrient Solution (Hoagland & Synder in 1933)

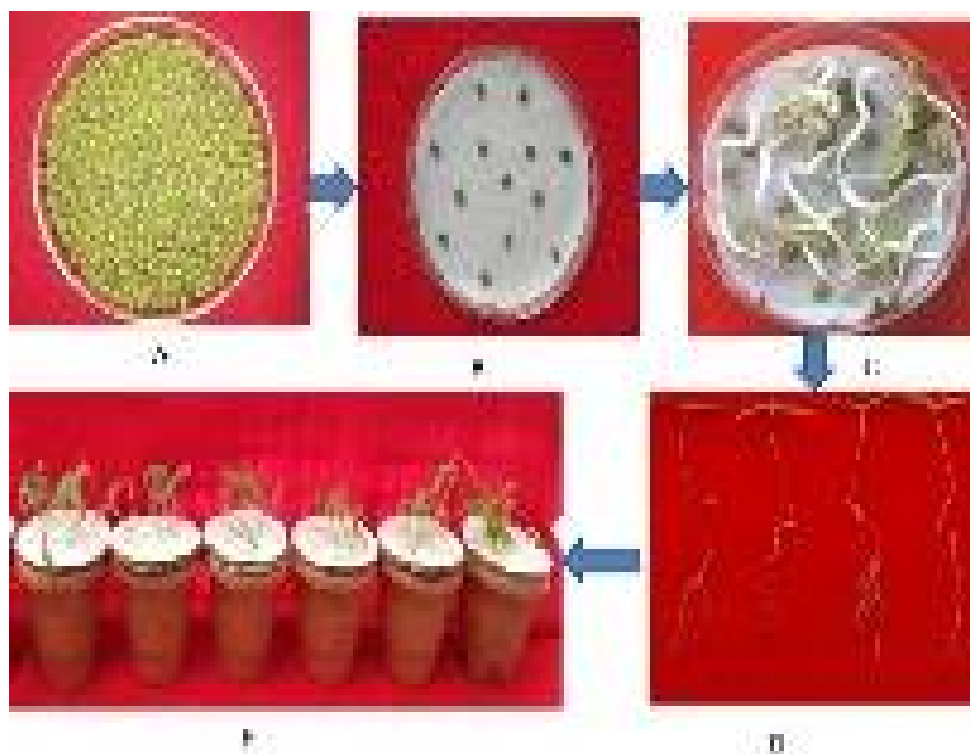
| S.No                             | Stock concentration                            |          |          |          |                | Working solution |  |
|----------------------------------|------------------------------------------------|----------|----------|----------|----------------|------------------|--|
| A. Macronutrients (single stock) |                                                |          |          |          |                |                  |  |
|                                  | Chemical                                       | gm/100ml | gm/200ml | gm/300ml | ml stock/liter |                  |  |
| 1                                | KNO <sub>3</sub>                               | 10.11    | 20.22    | 30.33    | 6              |                  |  |
| 2                                | Ca(NO <sub>3</sub> ) <sub>3</sub>              | 23.62    | 70.86    | 70.86    | 4              |                  |  |
| 3                                | NH <sub>4</sub> H <sub>2</sub> PO <sub>4</sub> | 11.51    | 23.02    | 34.53    | 2              |                  |  |
| 4                                | MgSO <sub>4</sub> .7H <sub>2</sub> O           | 24.65    | 49.3     | 73.95    | 1              |                  |  |
| B. Micronutrients (single stock) |                                                |          |          |          |                |                  |  |
| B1                               | KCl                                            | 0.186    | 0.372    | 0.558    | 2              |                  |  |
| B2                               | H <sub>3</sub> BO <sub>3</sub>                 | 0.77     | 1.54     | 2.31     |                |                  |  |
| B3                               | MnSO <sub>4</sub> .H <sub>2</sub> O            | 0.169    | 0.338    | 0.507    |                |                  |  |
| B4                               | ZnSO <sub>4</sub> .7H <sub>2</sub> O           | 0.0288   | 0.0576   | 0.0864   |                |                  |  |
| B5                               | CuSO <sub>4</sub> .5H <sub>2</sub> O           | 0.0062   | 0.0124   | 0.0186   |                |                  |  |
| B6                               | H <sub>2</sub> MoO <sub>4</sub>                | 0.0040   | 0.008    | 0.012    |                |                  |  |
| C.                               | NaFeEDTA                                       | 3g       | 6g       | 9g       | 1              | 200 μM           |  |

**Table 2: Effect of ZnO NPs on growth parameter of seedling of *V. radiata* at 14<sup>th</sup> day**

| S.No. | Conc. of ZnO NPs ( $\mu\text{M}$ ) | Root length (cm)  | Shoot length (cm) | Number of Leaves |
|-------|------------------------------------|-------------------|-------------------|------------------|
| 1.    | Control                            | $15.92 \pm 1.969$ | $13.96 \pm 2.212$ | $6.60 \pm 1.341$ |
| 2.    | 10                                 | $13.34 \pm 1.581$ | $13.66 \pm 1.053$ | $3.40 \pm 0.542$ |
| 3.    | 50                                 | $12.08 \pm 2.527$ | $10.70 \pm 4.211$ | $4.20 \pm 1.095$ |
| 4.    | 100                                | $13.42 \pm 1.432$ | $13.35 \pm 1.493$ | $5.75 \pm 1.500$ |
| 5.    | 150                                | $15.64 \pm 2.645$ | $16.08 \pm 2.639$ | $6.20 \pm 1.483$ |
| 6.    | 200                                | $18.14 \pm 4.166$ | $16.66 \pm 1.497$ | $6.20 \pm 1.483$ |



**Figure 1.** Morphological alteration in shoot and root length in *V. radiata* seedlings after treated with different concentration of ZnO NPs (10-200  $\mu\text{M}$ ) for a period of 14 days.



**Figure 2.** Represents the schematic procedure of the successful establishment of hydroponic culture. Seeds of *V. radiata* (A), sterilized seeds of *V. radiata* germinated in a petri dish under controlled conditions ( $25 \pm 2^\circ \text{C}$ ) (B), germinated seedlings (C), randomly selected seedlings of *V. radiata* at cotyledonary stages for the establishment of hydroponic cultures and (D), and successful establishment of hydroponic culture (E).

With the dramatic growing inside the field of nanotechnologies, it has come to be probably that, organic structures will be uncovered to extra of nanoparticles (NPs). But, the impact of Nano-particles on vegetation remains to be explored. Within the gift studies ZnO Nano-particles at lower concentration reduce seed germination and seedling increase, however at higher attention sell seed germination & seedling boom. Better attention of ZnO NPs as much as  $150 \mu\text{M}$  shows, higher boom in seedlings of *V. radiata*. The boom parameter of *V. radiata* changed into recorded maximum at higher awareness (one hundred – two hundred  $\mu\text{M}$ ).

The MDA content level, one of the main TBA reactive metabolites, decreased with increase in ZnO NPs awareness inside the leaf tissue. Lipid peroxidation depends upon the interest of lipoxygenase which oxidizes, and lipid to produce lipid hydroperoxides. The prevailing research determine the beneficial concentrations of nanoparticles that have a fine impact on the level of enzymes (Ez) in plant life as well as growth of vegetation.

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#### CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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