IMPACT OF BULK AND NANO-ZINC OXIDE ON GROWTH OF CICER ARIETRIUM (CHICKPEAS)

Medicine

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ABSTRACT

INTRODUCTION: Zinc oxide nanoparticles (ZnO-NPs) exhibit remarkable optical, physical, and antimicrobial properties and therefore have great potential to enhance agriculture. But the use of these NPs leads to their discharge and accumulation in the environment affecting both plant and animals systems, which emphasizes to study the toxicity of both bulk and NPs.

AIM: The present study is aimed at investigating the impact of ZnO-NPs and ZnO bulk particles on chickpeas.

METHOD: Two parameters were examined in this study: seed germination percentage and shoot length. Different concentration (250, 500, 1000 and 2000 mg/L) of ZnO-NPs and ZnO bulk particles were prepared in distilled water and used for the treatment in chickpeas.

RESULT: The study showed that the use of the ZnO-NPs and ZnO bulk particles both can reduce the seed germination and shoot length under controlled condition in comparison with control seed. With increase in the concentration from 250mg/L > 500mg/L > 1000mg/L > 2000mg/L the shoot length decreases

CONCLUSION: It was concluded that the ZnO-NPs affect the physiological expression of plant. It was found to stunt shoot length.

KEYWORDS

Zinc oxide, nanotoxicity, shoot length.

INTRODUCTION

Nanotechnology is emerging as the next wave of development and transformation of agri-food systems. It is attracting large-scale investment from global food corporations, is backed by academic science, and has captured financial and ideological support from many governments around the world. (1) In agriculture and food production, it is causing the agricultural land to return to its normal condition, greenhouse construction with high performance and productivity, preventing extinction and destruction of plants and animals species. Overall nanotechnology provides the efficiency of agriculture for growing population. (2)

ZnO-NPs is a commonly used metal NPs. It is used in a range of applications such as sunscreens and other personal care products, electrodes and biosensors, (3) photocatalysis and solar cells. Owing to increasing use in consumer products, it is likely that through both deliberate application and accidental release, these NPs will find their way into aquatic, terrestrial and atmospheric environments. (4,5) There is considerable concern about the potentially harmful effects of these NPs due to their unique properties, they may have significant effects on many organisms especially plant. (6) Most of these studies are focused on the potential toxicity of NPs to plants and both positive and negative or inconsequential effects have been reported. (7)

Nano Technological In Food Industry

Nanotechnology may also have the potential to enhance food quality and safety. Many studies are assessing the ability of nanosensors to improve pathogen detection in food systems. Nanofoods are products that were grown processed or packaged with the aid of nanotechnology or materials produced with nanotechnology. Current nanotechnology researches in food technology and agriculture includes processing, packaging, nano-additives, cleaning, and sensors for the detection of contaminants and propose future developments in the field of agri-food nanotechnology. (8)

Most nanoencapsulates have shown excellent bioavailability and few encapsulates have reported good inhibitory effect against certain targeted diseases. However, presently, the possible risks of nanomaterials to human health is unknown and need to be explored and studied. (9)

MATERIALS AND METHODS

TEST CHEMICAL PROCUREMENT

ZnO-NPs were purchased from Nanoshel, Intelligent Materials Pvt. Ltd. Haryana, India. The ZnO bulk particles were purchased from Faridabad, Haryana.

PROPERTIES OF NANO-ZnO

Weight – min 93 %, Alumina – Yes, Amorphous silica – Yes, Specific gravity – 4.0, Bulking value/L/Kg (gal/lb) – 0.25 (0.03), Organic treatment – Yes, Color CIE L* – 99.6, Median particle size – 35-45 nm.

Appearance – white or pale yellow powder, Purity – 99.7%, Grain size – 20-50nm, Specific surface area (m²/g) > 90, Loss on drying < 0.3%, Loss on burning < 0.2%, Pb < 0.037%, Mn < 0.0001%, Cu < 0.0002%.

PREPARATION OF TEST SOLUTION

The bulk and NPs were suspended directly in distilled water and dispersed. Four concentrations viz. 250, 500, 1000 and 2000 mg/L of both bulk and NPs were used and for all experiments freshly prepared solutions were used.

TEST SYSTEM

Commercially available seeds of common chickpeas were used as the test system.

SEED GERMINATION TEST

The seed germination bioassay was evaluated according to the procedure of Environmental Protection Agency (EPA). For each treatment triplicate of 50 healthy and uniform size seeds were used. Seeds were surface sterilized with 10% sodium hypochlorite for ten minutes then washed with sterile distilled water and placed on sterile filter paper in the Petri dishes. Fresh test solutions were added to the Petri dishes and the plates were placed in a B.O.D incubator in the dark for 120 h at 25 ± 1°C to facilitate linear growth.

MEASUREMENT OF SHOOT LENGTH

For each experiment triplicate of each 50 healthy and uniform size seeds were used. The seeds were sowed in the cups containing sand. Fresh test solutions were added in the cups and kept in the natural environmental for 10 days to grow and subsequently on the 10th day the shoot length is measured.

Statistical analysis

Each treatment was conducted with three replicates, and the results

were presented as mean $\pm$ SE. Comparisons between the control and treated groups were evaluated by one way ANOVA using SPSS software package and $P<0.05$ was considered as the level of significance and the level of one factor was compared to each level of the other factor by all pair wise multiple comparison procedures (Turkey's test).

RESULTS AND DISCUSSION

Table 1: Mean shoot length score for different concentration of ZnO-NPs and ZnO bulk particles under controlled conditions.

S.no	Dilution	ZnO-NPs (mm)	Bulk ZnO (mm)	F value	p-value
1.	0.25gm/ liter	20 $\pm$ 00c	20 $\pm$ 00	5.333	0.047*
2.	0.5gm/ liter	19 $\pm$ 1c	24 $\pm$ 1	13.364	0.006*
3.	1gm/ liter	11 $\pm$ 1ac	22 $\pm$ 1ab	24.818	0.001*
4.	2gm/ liter	10 $\pm$ 1ac	21 $\pm$ 1ab	24.818	0.001*

Anova ($p<0.05$) mean value with same superscripts are significantly different as tested by ANOVA POST HOC test. Mean shoot length scores of control sample in water is 16 $\pm$ 3mm

The above table showed that there was a rapid increase in the shoot length in lowest concentration of Nano ZnO and bulk ZnO whereas the control sample showed relatively less growth. The highest growth was 20mm in 0.25gm/litre bulk ZnO and Nano ZnO whereas in concentration 2gm/litres showed 10 $\pm$ 1 (Nano ZnO) lowest mean value but in bulk ZnO showed 21 $\pm$ 1 which is high as compare to Nano ZnO. This result revealed that there was significant difference ($p<0.05$) between all concentration of bulk ZnO and Nano ZnO.

Table 2: Seed germination percentage for different concentration of ZnO-NPs and ZnO bulk particles under controlled conditions.

S.no	Dilution	ZnO- NPs	Bulk ZnO	Control
1)	0.25gm/ liter	96%	96%	96%
2)	0.5gm/ liter	92%	92%	
3)	1gm/ liter	86%	92%	
4)	2gm/ liter	56%	92%	

For seed germination% it was found that the chickpeas seeds showed highest germination rate at concentration 0.25gm/liter in Nano ZnO, bulk ZnO and controlled sample. And relatively decrease the seeds germination in Nano ZnO with the increase in concentration of Nano ZnO. But in case of bulk ZnO showed similar germination percentage (92%) at 0.5/1litre, 1gm/liter and 2gm/liter.

Table 3: Mean Shoot length scores of different concentration of ZnO-NPs and bulk ZnO under natural environment.

S.no	Dilution	ZnO-NPs(mm)	Bulk ZnO(mm)	F value	p-value
1)	0.25gm/ liter	111 $\pm$ 1ac	70 $\pm$ 1ab	1861.00	0.001*
2)	0.5gm/ liter	105 $\pm$ 1ac	49 $\pm$ 1ab	3796.00	0.002*
3)	1gm/ liter	103 $\pm$ 1ac	51 $\pm$ 1ab	3472.00	0.045*
4)	2gm/ liter	65 $\pm$ 1ac	51 $\pm$ 1ab	3396.00	0.001*

Mean shoot length in control sample is 115 $\pm$ 1mm

Anova ($p<0.05$) mean value with same superscripts are significantly different as tested by ANOVA POST HOC test. The result indicated that the shoot length was highest in controlled sample (115 $\pm$ 1) whereas in lowest concentration of bulk ZnO and Nano ZnO showed relatively high shoot length. Maximum shoot length was found at the concentration 0.25gm/litre (111 $\pm$ 1) in Nano ZnO. The shoot length has significantly increased with the decrease in concentration of Nano particles zinc oxide. The results were statistically significant ($p>0.05$).

DISCUSSION AND CONCLUSION

The present study used different concentration of bulk ZnO and Nano ZnO to assess the shoot length under controlled condition, germination percentage and shoot length under natural environment condition in Cicer Arietrium(chickpeas).

The data under controlled conditions revealed that there was a rapid increase in the shoot length at lowest concentration of Nano ZnO and

bulk ZnO whereas the control sample showed relatively less growth. Bulk ZnO and Nano ZnO showed the similar highest mean value i.e 20 $\pm$ 00mm at 0.25gm/litre concentration whereas at concentration of 2gm/litres Bulk ZnO showed 21 $\pm$ 1mm highest and Nano ZnO showed 10 $\pm$ 1mm (Nano ZnO) lowest mean value of shoot length.

The highest mean score of germination percentage in Nano ZnO, bulk ZnO and controlled sample was indicated at concentration of 0.25gm/liter i.e.96%.

The data revealed that the controlled sample show highest mean value of shoot length under natural environmental condition i.e 115 $\pm$ 1mm .In case of Nano treated sample maximum shoot length was found at the concentration of 0.25gm/litre i.e.111 $\pm$ 1mm.As the concentration increased from 0.25gm/liter >0.5gm/liter>1gm/litre>2gm/liter, the shoot length decreased.

The experimental results from the present study showed that Nano particle treated seeds have higher inhibition on the germination percentage, seedling growth, shoot and root length than bulk particles. This may be understood by the adherence of Nano ZnO particles to the root surface and inhibiting its morphological growth. Also it can be attributed to the fact that Nano ZnO are insoluble in water and the particles are rapidly lost from solution, probably due to sedimentation as a result of aggregation or sensitivity of the treated test subject. It can be concluded that ZnO NPs does exhibit significant phytotoxicity.

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