Research Note
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EFFECT OF NANOSCALE ZINC OXIDE ON YIELD AND ZINC UPTAKE IN GREEN GRAM

T. USHA RANI*, T.N.V.K.V PRASAD and O. SIVA DEVIKA.

Agricultural College, Rajamahendravaram - 533101.
Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh, India

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Nanotechnogy is a progressive field in the 21st century. Nanoparticles gained considerable attraction due to their unusual and engaging properties with various applications (Sabir *et al.*, 2014).Nanoparticles may be prepared chemically, physically, or by a biological methods. They provide a good means to distribute the fertilizers in a very controlled fashion with high site specificity (Sabir *et al.,* 2012). The aim of nanomaterials in agriculture is to reduce the amount of spread chemicals, minimize nutrient losses in fertilization and increased yield through water and nutrient management. Therefore, there is dire need to evaluate the field scale efficiency of nanoscale materials on different crops in conjunction with the varied agro-climatic situations. Prasad *et al.,* (2012) reported that nanoscale zinc oxide particles with mean size 25 nm increased pod yield up to 30% in groundnut with the foliar application @ 2 g/15 lit at 30 & 60 DAS. All the physiological parameters were significantly enhanced with the application of nanoscale zinc oxide particles. Subbaiah *et al.,* (2016) reported that application of nanoscale zinc oxide enhanced maize yield to the extent of 15 percent. Further, it was reported that significant grain zinc content (36 ppm) recorded against the application of 100 ppm of nanoscale zinc oxide particles. The individual application of ZnO NPs and *B. fortis* IAGS 223 slightly enhanced the growth characteristics, including photosynthetic pigments, gas exchange parameters, and antioxidative system of *Cucumis melo* seedlings under Cd stress.The nanoparticles affect negatively if their concentration and time exceed. The effects of nanoparticles on different plant species can differ significantly with plant growth stages and method and duration of exposure and also depend on nanoparticle size, concentration, chemical composition, surface structure, solubility, shape, and aggregation (Parthasarathi *et al.*, 2011). Another study showed the effect of zinc oxide nanoparticles on plants like radish, rape, ryegrass, lettuce, corn and cucumber was studied, which showed that the germination was not fully affected by the zinc nanoparticles (Sabir *et al.*, 2014).In view of this, a study was conducted to study the zinc oxide nano particles use as a fertilizer and for growth stimulatory effects on different pulses like green gram crop.

A field experiment was conducted during *kharif* season at Agricultural Research Station, Peddapuram in 2020 and 2021 with a tested variety WGG 37. The experiment was laid out in randomized block design with eight treatments with a plot size for each treatment 8m x 4m with a spacing of 30 cm x 10cm. The experimental soil was neutral in reaction (7.6) normal in electrical conductivity (0.38 dSm^{-1}),

*Corresponding Author Email: t.usharani@angrau.ac.in

low in organic carbon (0.41%) and available nitrogen (262 kg/ha) and medium in available phosphorus (38 kg/ha) and potassium (265 kg/ ha).The experiment was conducted on effect of nanoscale zinc oxide influence on greengram yield and zinc content in plant and grain during kharif season. The treatment details are T1 : Control, T2 : RDF, T3 : soil application of ZnSO4 @50kg/ha, T4 : foliar application of $ZnSO_4$ @2g/lit at 25 and 40 DAS, T5: foliar application of nanoscale zinc oxide @ 2g/15 lit at 25 & 40 DAS, T6 : Foliar application of nanoscale ZnO @ 2g/ 10 lit at 25 ,40 DAS, T7 : Foliar application of nanoscale ZnO @ 1g/15 lit at 25 and 40 DAS, T8 : Foliar application of nanoscale ZnO @ 1g/ 10 lit at 25 and 40 DAS along with FYM for the treatments from T3 to T8. The crop was sown during late kharif season on 24.08.2020. The recommended dose of fertilizersfor the green gram during kharif season were 20 kg N+50 kg P_2O_5/ha. Nitrogen applied in the form of urea in two splits one as basal and second dose at flowering stage. The phosphorus fertilizer in the form of single super phosphateapplied as basal only.When the crop required necessary field operations like weeding and pest and disease control were carried out. The analysis of soil was conducted as per the approved procedures. The grain samples were analysed for N,P,K and zinc content. The nano scale zinc oxide with a mean range of 25nm was prepared at Tirupathi laboratory and supplied for the experiment purpose.The initial and post-harvest soil samples were collected and analysed for pH, electrical conductivity, available nitrogen, Phosphorus, Potassium and Zinc in soils, grain and stover. The crop was irrigated once at the early stage of crop growth (20 days after sowing). The plant samples were collected at harvest. The grain samples were collected from 10 plants on an average from each treatment and analysed for N, P, K and zinc content.

Statistical analysis

The eight treatments were replicated thrice and the results were presented as mean + standard deviation (SD). The statistical analysis of experimental data utilized the ANOVA program.

Application of foliar nutrition improved the plant height resulted in taller plants with more number of leaves. The plant height found maximum with the spraying of nano scale zinc oxide @ 2g/15 lit at 25 and 40 days after sowing (59.9 cm) Table 1. This was confirmed withthe results of Prasad *et al.,* 2012, reported that the nanoscale ZnO increased plant height and days to initiation of flowering irrespective

The standard procedures for analyzing soil, plant and grain samples were mentioned below.

S.No	Nutrient	Method of analysis	
1	Soil available N	Alkaline permanganate method by Subbaiah and Asija	
2	Soil available P	Olsen's method	
3	Soil available K	Neutral Normal Ammonium method	Soil, Plant, Water and Fertilizer Analysis, P.K. Gupta
4	Plant N	Micro Kjeldahl method	
5	Plant P	Vanado-molybdate method	
6	Plant K	Flame photometer	

of concentrations compared to bulk $ZnSO_4$ in peanut. Nanoscale ZnO showed large root growth of seedling compared to bulk $ZnSO_4$ and control. Such results were in confirmation with Lu *et al.*and Prasad *et al.,* 2012. This may be due to increased nitrate reductase enzyme activity and enhanced antioxidant system. Foliar application of zinc significantly increased green grams height and number of leaves compared to soil applied zinc. The significant increase in height and leaf number by foliar applied zinc can be attributed to improve of zinc uptake by plants from the soil which plays very important role in plant metabolism by influencing the activities of hydrogenase and carbonic anhydrase, stabilization of ribosomal fractions and synthesis of cytochrome. Plant enzymes activated by Zn are involved in carbohydrate metabolism, maintenance of the integrity of cellular membranes, protein synthesis, regulation of auxin synthesis and pollen formation. The regulation and maintenance of the gene expression required for the tolerance of environmental stresses in plants are Zn dependent (Cakmak, 2008).

Similar results on increased plant height when soil zinc was applied have been reported by Khorgamy and Farnia (2009) in Chickpea. The results on effect of nano scale zinc oxide and zinc bio fortification studies indicated that foliar application of nano zinc @2g/ 10 lit at 25 and 40 days after sowing recorded maximum grain yield (1327 kg/ha) which was significantly on par with the application of foliar application of nano Zinc @2g/ 15 lit at 25 and 40 days (1278 kg/ha). The same trend was observed in pod yield also due to thepromotory effect of nanoscale ZnO at 2 g/10 L of water which increase the pod yield and number of filled pods per plant (12 no) and inhibitory effect at higher concentrations.As per the findings of Harish *et al.,(*2017) indicated significant increase in number of pods per plant, pod yield per plant and also plant height with the application of nanoscale ZnO at 6 g in 6 L when compared to RDF. The stover yield was found maximum with the application of RDF along with nano scale zinc oxide @2g/10 lit at 25 and 40 days after sowing (2016.7 kg/ha) which was significantly on par with the spraying of nano scale zinc oxide @ 2g/10 lit at 25 and 40 days after sowing (2292 kg/ha). The test weight also found maximum with the application of nano scale zinc oxide @ 2g/10 lit at 25 and 40 days after sowing (35.7g) which was significantly on par with the application of nano scale zinc oxide @ 2g/15 lit at 25 and 40 days after sowing. (Table 1). Slaton *et al.,* (2001) reported that treating rice seeds with nano zinc greatly increased grain yield and concluded that this type of Zn application is more economical alternative to more expensive broadcast Zn fertilizer application. The exact reason for these effects was not known but may be due to high concentration of zinc in the grain when treated with nanoscale zinc oxide.

The study suggests that zinc oxide in the nanoscale form is absorbed by plants to a larger extent unlike bulk $ZnSO_4$. These particles proved effective in enhancing plant growth, development and yield. The nanoscale nutrients at high concentrations are detrimental just as the bulk nutrients. Nanoscale ZnO, which is having less hydrophilicity and being more dispersible in lypophilic substances compared to the ions, can penetrate through the leaf surface (Da Silva *et al.*, 2006) compared to $ZnSO_4$.

The zinc content in grain found maximum with the foliar application of nano zinc @ 1g/ 15L at 25 and 40 DAS(Table 2). The mobility of the nanoparticles is known to be very high which ensures the phloem transport and ensures the nutrient to reach all parts of the plant. The presence of nanoparticles both in the extracellular space and within some cells in the living plant Cucurbita pepo was reported

Table 1. Effect of nanoscale zinc oxide on the yield parameters of greengram during Kharif

Treatments	Plant height (cm)	No.of pods /plant	No.of grains /pod	Grain yield (kg/ha)	*Stover* yield (kg/ha)	1000 seed weight (g)
T1 : Control	51.8	24	10	689	1033.3	31.8
T2 : RDF	57.0	24	10	861.1	1291.7	33.7
T3 : Soil application $ZnSO_4$@ 50kg/ha	58.8	26	10	1033.3	1550.0	34.2
T4 : Foliar application $ZnSO_4$ 2 g/L at 25 & 40DAS	54.6	26	11	1155.6	1733.3	34.9
T5 : Foliar application of nanoscale ZnO@ 2 g/15L at 25 & 40DAS	59.9	28	11	1277.8	1916.7	35.2
T6 : Foliar application of nanoscale ZnO@2 g/10L at 25 & 40DAS	57.4	27	11	1327.8	2291.7	35.7
T7 : Foliar application of nanoscale ZnO@ 1 g/15L at25 & 40DAS	59.7	29	12	944.4	1416.7	35.0
T8 : Foliar application of nanoscale ZnO@1 g/10L at 25 & 40DAS	55.9	25	12	1172.2	1758.3	33.6
CD at 5%	0.88	1.38	0.53	327.64	491.46	0.93
Sem$^{+}_{-}$	0.29	0.46	0.18	108.26	162.39	2.80
CV%	**9.2**	**8.6**	**7.8**	**9.7**	**10.28**	**8.27**

***RDF** is applied uniformly from T3 to T8 @20 kg N+50 kg P_2O_5/ha in two splits at basal and flowering stages

(Gonzalez-Melendi *et al.*, 2008). The bioavailability of the nanoparticle can also be higher compared to chelated ZnSO4.

In order to understand the possible benefits of applying nanomaterials in agriculture, it is important to analyze penetration and transport of nanoparticles in the plants. Size plays an important role in behavior, in reactivity and in toxicity. Considering these aspects, both positive and negative effects of nanoparticles are observed in living plants. Foliar application of nanoscale zinc oxide @ 2 g per 10 L of water at 25 and 40 days after sowing (DAS) recorded the highest grain yield, which was statistically on par with the application of nano zinc oxide @ 2 g per 15 L of water at the same stages. A similar trend was observed for grain yield, stoveryield and test weight. The results thus indicate that significant zinc uptake by the leaf and kernel was observed with the foliar application of nanoscale ZnO compared to chelated zinc sulfate.

REFERENCES

Cakmak, I. 2008. Enrichment of cereal grains with zinc: agronomic or genetic biofortification. Plant and soil, 302: 1-17.

Table 2. Effect of nanoscale zinc oxide on the zinc concentration in grain and stover of greengram during Kharif.

Treatments	Zn concentration (mg/100g)	
	Grain	Stover
T1 : Control	1.6	3.3
T2 : RDF	2.1	3.8
T3 : Soil application $ZnSO_4$ @ 50kg/ha	2.6	4.4
T4 : Foliar application $ZnSO_4$ @2 g/L at 25 & 40DAS	2.6	4.8
T5 : Foliar application of nanoscale @ZnO 2 g/15L at 25 & 40DAS	3.0	4.7
T6 : Foliar application of nanoscale @ZnO 2 g/10L at 25 & 40DAS	3.4	4.9
T7 : Foliar application of nanoscale @ZnO 1 g/15L at25 & 40DAS	3.3	5.0
T8 : Foliar application of nanoscale @ZnO 1 g/10L at 25 & 40DAS	2.6	4.5
CD at 5%	0.16	0.40
Sem	11.71	0.13
CV %	7.5	9.8

*****RDF is applied uniformly from T3 to T8 @ 20 kg N+50 kg P_2O_5/ha in two splits at basal and flowering stages

Gonzalez-Melendi, P., Fernandez - Pacheco, R., Coronado, M. J., Corredor, E., Testillano, P. S.,Risueno,M.C. and Perez-de-Luque, A. 2008. Nano particles as smart treatment - delivery systems in plants : assessment of different techniques of microscopy for their visualizarion in plant tissues. Annals of botany, 101(1):187-195.

Harish, M. S. and Rame Gowda, R. G. 2017. Effect of nanoscale zinc oxide on plant growth, seed yield and quality in groundnut. Mysore Journal of Agric. Sciences, 51 (3): 637-643.

Khorgamy, A. and Farnia, A. 2009. Effect of phosphorus and zinc fertilization on yield and yield components of chick pea cultivars. Afr Crop Sci Conf Proc. 9, 205-208.

Lu Chang Mei, L. C., Zhang ChaoYing, Z. C., Wen Jun Qiang, W. J., Wu GuoRong, W. G. and Tao MingXuan, T. M. 2002. Research of the effect of nanometer materials on germination and growth enhancement of Glycine max and its mechanism. Soybean Science, 21 (3): 168-171.

Parthasarathi, T. 2011. Phytotoxicity of nanoparticles in agricultural crops. In International Conference on Green technology and environmental Conservation (GTEC-2011), 51-60.

Prasad, T. N. V. K. V., Sudhakar, P., Sreenivasulu, Y., Latha, P., Munaswamy, V., Reddy, K. R. and Pradeep, T. 2012. Effect of nanoscale zinc oxide particles on the germination, growth and yield of peanut. Journal of plant nutrition, 35(6): 905-927.

Sabir, S., Arshad, M. and Chaudhari, S. K. 2014. Zinc oxide nanoparticles for revolutionizing agriculture: synthesis and applications. The Scientific world journal, 2014(1): 925494.

Da Silva, L. C. D., Oliva, M. A., Azevedo, A. A. and Araujo, J. M. D. 2006. Responses of restinga plant species to pollution from an iron pelletization factory. Water, Air, and Soil Pollution, 175: 241-256.

Slaton, N. A., Wilson, C. E., Ntamatungiro, S., Norman, R. J. and Boothe, D. L. 2001. Evaluation of zinc seed treatments for rice. Agronomy Journal, 93(1): 152-157.

Subbaiah, L. V., Prasad, T. N. V. K. V., Krishna, T. G., Sudhakar, P., Reddy, B. R. and Pradeep,T. 2016. Novel effects of nanoparticulate delivery of zinc on growth, productivity and zincbio for tification in maize (*Zea mays* L.). Journal of Agricultural and Food Chemistry, 64(19): 3778-3788.

Usha rani, T., Prasad, T.N.V.K.V. and Siva devika, O. 2026. Effect of nanoscale Zinc Oxide on yield and Zinc uptake in Green gram.The Journal of Research ANGRAU, 54(1): 106-111