

# Original Research Article

Effect of nanoscale zinc oxide particles on **macronutrient** concentration of Groundnut

(*Arachishypogaea* L.)

Authors or manuscript correspondent???

Comment [ZS1]: which macronutrient? Carbohydrates, fat and protein or Nutrients (NPKSMg...etc??) it would be better to indicate in the title

## Abstract

In the present investigation, size dependent effects of nanoscale zinc oxide particulates (n-ZnO) on the macronutrient concentration of groundnut leaf, stem and kernel have been analysed. ZnO-nanoparticulates that were used in the study were prepared by modified oxalate decomposition method and the ZnO-nanoparticulates (mean size of 20, 25 and 30 nm) were characterized using techniques such as transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FT-IR), Dynamic light scattering (DLS) and X-ray diffraction analysis (XRD). Different concentrations (150, 200 and 400 ppm) of ZnO-nanoparticulates were applied (foliar spray) to reveal their effects on groundnut crop in comparison to bulk ZnSO<sub>4</sub>. These results indicate that zinc nanoparticles significantly influenced the macronutrient (N, P and K) concentration of groundnut depending on their size and concentration.

Comment [ZS2]: it will be very nice to indicate (what kind of influence and give the results core figures??)

you have still chance to add 38 word more in the abstract!!

**Key words:** n-ZnO, size, concentration, macronutrients, Groundnut crop.

## 1. INTRODUCTION

Nanoscale materials (size ~~<less than~~ 100 nm ~~in at least one dimension~~) exhibits unique and novel properties compared to their bulk counter parts (Prasad et al., 2012). However, the application of nanoscale materials in agriculture as nutrients is relatively new and the record of consequent effects on crops is scant (reference?). Further more, it is clear from the theory that nanoscale materials possess size dependent characteristics and reactivity and also are distinct to each other (reference??). Nanotechnology plays a vital role in improving soil health, nutrient management, weed management, pest and disease control, through the new scientific approaches to increase production and productivity of crops (refence???).

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The present study examines the interactions between Zn and other nutrients in soil, behaviour in plant growth. It stresses the need for identification of the factor responsible for any Zn response to the addition of another nutrient compound. Of the many interactions of Zn with other nutrients, the most widespread and important to crop production are those with N and P

30 fertilizers on soils with limiting supplies of both Zn and N or P. Similar interactions of Zn with  
31 other essential nutrients will also be important in soils with low fertility. It helps to introduce new  
32 techniques through enabling slow and controlled release of nutrients from fertilizers, efficient  
33 and targeted delivery of fertilizers coupled with enabling resistance, effective processing, storage  
34 and packing. Nanoparticles have smaller particle sizes, higher specific surface area and an  
35 increased proportion of reactive surface atoms as compared to bulk particles [12]. Zinc  
36 nanoparticles are being used in various agricultural experiments by the researchersto understand  
37 its effect on growth, germination, and various other properties[8, 11, 6, and 9]and reported  
38 encouraging results.

Comment [ZS3]: This is inconsistent with the reference mentioned above, follow one procedure number or quote reference!!

## 39 2. MATERIALS AND METHODS:

40 ZnO nanoparticles of mean size of 20, 25, 30 nm diameter were used in the study.  
41 Nanocrystalline zinc oxide has been prepared by using the oxalate decomposition technique.  
42 Zinc oxalate was prepared by mixing equimolar (0.2 M) solutions of zinc acetate and oxalic acid.  
43 The resultant precipitate was collected and rinsed extensively with double deionized water (DI-  
44 water) and dried in air. The oxalate was then ground and decomposed in air by placing it in a  
45 pre-heated furnace for 45 minutes at 500°C. The characterization of the samples was done by  
46 Dynamic Light Scattering analysis, Transmission Electron Microscopy. The TEM samples were  
47 prepared by drop casting the suspensions on carbon coated Cu grids.

48 The experiment was conducted at College farm, S. V. Agricultural College, Acharya  
49 N.G. Ranga Agricultural University, Tirupati during *Kharif*, 2018-19. The experiment was laid  
50 out in sandy clay loam textured soil in a randomized block design (RBD) with three replications  
51 and with the plot size of 4m×4m. The initial soil parameters were pH 6.42 (neutral); EC= 0.132  
52 dSm<sup>-1</sup>; organic carbon = 0.50% (low); available nitrogen = 188.16 kg ha<sup>-1</sup>  
53 (low); available P<sub>2</sub>O<sub>5</sub> = 14.66 kg ha<sup>-1</sup>; available K<sub>2</sub>O= 564.4 kg ha<sup>-1</sup> (high); available zinc = 16.6  
54 ppm; and total zinc content of 21.3 ppm. Laboratory analysis is done by following standard  
55 procedures given by Jackson, [4] and piper, [7].

Comment [ZS4]: Not defined!!

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56 Field experiment was carried out in *khariif* 2018 with twelve treatments and three  
57 replications. The treatments were *viz.*, control *i.e.*, no application (T<sub>1</sub>), Recommended Dose of  
58 Fertilizer RDF (T<sub>2</sub>), RDF + Zinc sulphate @ 2000 ppm at 25 and 45 DAS (T<sub>3</sub>), RDF + Nanoscale  
59 zinc oxide (20 nm) @ 400 ppm (T<sub>4</sub>), -RDF + Nanoscale zinc oxide (20 nm) @ 200 ppm (T<sub>5</sub>),

60 RDF + Nanoscale zinc oxide (20 nm) @ 150 ppm (T<sub>6</sub>), RDF + Nanoscale zinc oxide (25 nm) @  
61 400 ppm (T<sub>7</sub>), RDF + Nanoscale zinc oxide (25 nm) @ 200 ppm (T<sub>8</sub>), RDF + Nanoscale zinc  
62 oxide (25 nm) @ 150 ppm (T<sub>9</sub>), RDF + Nanoscale zinc oxide (30 nm) @ 400 ppm (T<sub>10</sub>), RDF +  
63 Nanoscale zinc oxide (30 nm) @ 200 ppm (T<sub>11</sub>) and RDF + Nanoscale zinc oxide (30 nm) @  
64 150 ppm (T<sub>12</sub>).

### 65 3. RESULTS AND DISCUSSION

66 The data on post-harvest concentration of macronutrients (N, P and K) in leaf, stem and  
67 kernel at harvests influenced by the application of nanoZnO and bulk ZnSO<sub>4</sub> are presented in  
68 the Table 1.

#### 69 3.1 Concentration of macronutrients in leaf, stem, and kernel at harvest

##### 70 3.1.1 Nitrogen content (%)

71 At harvest, the concentration of nitrogen in groundnut leaves, and in stem was  
72 numerically higher, ~~in~~ when compared to control and bulk ZnSO<sub>4</sub> @ 2000 ppm but ~~they are~~  
73 ~~not the differences were not statistically~~ significant ( $P < ??$ ) ~~by different~~. Highest leaf N content  
74 (0.84 %) was observed in treatment of 100 % RDF (T<sub>2</sub>). Whereas, highest stem N content  
75 (0.70%) was observed in treatment (T<sub>7</sub>) n-ZnO of size 25nm @ 400 ppm over other treatments.  
76 Statistically significant ( $P < ??$ ) high kernel N content (0.49 %) was observed in T<sub>10</sub> treatment n-  
77 ZnO of size 30 nm @ 400 ppm which is 45 % more than control and 49 % more than bulk  
78 ZnSO<sub>4</sub> @ 2000 ppm.

Comment [ZS9]: No needed

##### 79 3.1.2 Phosphorous content (%)

80 Phosphorous content in groundnut leaves, stem and kernel was significantly ( $P < ??$ ) higher  
81 when compared to control and bulk ZnSO<sub>4</sub> @ 2000 ppm. Highest leaf P content (0.23 %) was  
82 observed in treatment n- ZnO of size 30 nm @ 400 ppm (T<sub>10</sub>) which is 73 % more than control,  
83 43 % more than bulk ZnSO<sub>4</sub> @ 2000 ppm and it is on par with T<sub>11</sub> (0.22) n- ZnO of size 30 nm  
84 @ 200 ppm. The next best treatments were T<sub>9</sub> (0.17%) and T<sub>12</sub> (0.14%).

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Comment [ZS10]: Inconsistent!!

85 Highest stem P content (0.27 %) was observed in treatment T<sub>10</sub> (n-ZnO of size 30 nm @  
86 400 ppm) which is 70 % more than control and 66.6 % more than bulk ZnSO<sub>4</sub> @ 2000 ppm.

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T <sub>1</sub> : control	0.14 <sup>c</sup>	0.17 <sup>b</sup>	0.27 <sup>de</sup>	0.06 <sup>e</sup>	0.08 <sup>e</sup>	0.06 <sup>e</sup>	0.86 <sup>cd</sup>	0.95 <sup>cde</sup>	0.56 <sup>b</sup>
T <sub>2</sub> : RDF	0.84 <sup>a</sup>	0.60 <sup>ab</sup>	0.44 <sup>ab</sup>	0.1 <sup>cde</sup>	0.13 <sup>bcd</sup>	0.08 <sup>de</sup>	0.84 <sup>d</sup>	0.97 <sup>bcd</sup>	0.60 <sup>b</sup>
T <sub>3</sub> : RDF + ZnSO <sub>4</sub> @ 2000 ppm	0.39 <sup>abc</sup>	0.26 <sup>ab</sup>	0.25 <sup>e</sup>	0.13 <sup>bcd</sup>	0.09 <sup>de</sup>	0.09 <sup>cd</sup>	0.83 <sup>d</sup>	0.89 <sup>de</sup>	0.63 <sup>ab</sup>
T <sub>4</sub> : RDF + Nano ZnO (20nm) @ 400 ppm	0.28 <sup>abc</sup>	0.38 <sup>ab</sup>	0.35 <sup>bcd</sup>	0.11 <sup>cde</sup>	0.12 <sup>bcd</sup>	0.09 <sup>cd</sup>	1.08 <sup>a</sup>	0.94 <sup>cde</sup>	0.63 <sup>ab</sup>
T <sub>5</sub> : RDF + Nano ZnO (20 nm) @ 200 ppm	0.27 <sup>abc</sup>	0.23 <sup>ab</sup>	0.31 <sup>cde</sup>	0.12 <sup>cd</sup>	0.17 <sup>b</sup>	0.12 <sup>abc</sup>	0.94 <sup>bcd</sup>	0.94 <sup>cde</sup>	0.60 <sup>b</sup>
T <sub>6</sub> : RDF + Nano ZnO (20 nm) @ 150 ppm	0.37 <sup>abc</sup>	0.25 <sup>ab</sup>	0.35 <sup>bcd</sup>	0.14 <sup>bcd</sup>	0.16 <sup>bc</sup>	0.12 <sup>abc</sup>	0.85 <sup>d</sup>	0.84 <sup>e</sup>	0.60 <sup>b</sup>
T <sub>7</sub> : RDF + Nano ZnO (25 nm) @ 400 ppm	0.79 <sup>ab</sup>	0.70 <sup>a</sup>	0.40 <sup>abc</sup>	0.09 <sup>de</sup>	0.1 <sup>de</sup>	0.13 <sup>abc</sup>	0.98 <sup>abc</sup>	1.12 <sup>a</sup>	0.63 <sup>ab</sup>
T <sub>8</sub> : RDF + Nano ZnO (25 nm) @ 200 ppm	0.40 <sup>abc</sup>	0.27 <sup>ab</sup>	0.35 <sup>bcd</sup>	0.12 <sup>cd</sup>	0.11 <sup>cde</sup>	0.15 <sup>ab</sup>	0.99 <sup>ab</sup>	1.09 <sup>ab</sup>	0.70 <sup>a</sup>
T <sub>9</sub> : RDF + Nano ZnO (25 nm) @ 150 ppm	0.29 <sup>abc</sup>	0.25 <sup>ab</sup>	0.40 <sup>abc</sup>	0.17 <sup>b</sup>	0.14 <sup>bcd</sup>	0.13 <sup>abc</sup>	1.03 <sup>ab</sup>	0.95 <sup>cde</sup>	0.60 <sup>b</sup>
T <sub>10</sub> : RDF + Nano ZnO (30 nm) @ 400 ppm	0.17 <sup>bc</sup>	0.23 <sup>ab</sup>	0.49 <sup>a</sup>	0.23 <sup>a</sup>	0.27 <sup>a</sup>	0.11 <sup>bcd</sup>	0.92 <sup>bcd</sup>	0.98 <sup>bcd</sup>	0.56 <sup>b</sup>
T <sub>11</sub> : RDF + Nano ZnO (30 nm) @ 200 ppm	0.29 <sup>abc</sup>	0.26 <sup>ab</sup>	0.37 <sup>bc</sup>	0.22 <sup>a</sup>	0.11 <sup>cde</sup>	0.11 <sup>bcd</sup>	0.95 <sup>bcd</sup>	1.03 <sup>abc</sup>	0.70 <sup>a</sup>
T <sub>12</sub> : RDF + Nano ZnO (30 nm) @ 150 ppm	0.29 <sup>abc</sup>	0.34 <sup>ab</sup>	0.41 <sup>abc</sup>	0.14 <sup>bc</sup>	0.11 <sup>cde</sup>	0.16 <sup>a</sup>	1.03 <sup>ab</sup>	1.10 <sup>ab</sup>	0.63 <sup>ab</sup>
SE(m)	0.18	0.14	0.030	0.013	0.016	0.012	0.039	0.04	0.024
CD	NS	NS	0.09	0.039	0.047	0.036	0.110	0.110	0.069

Comment [ZS15]: Table is not standard!!

113 \*The mean values were separated by Duncan's Multiple Range Test (DMRT)

114 **4. Conclusions**

115 While Zn interacts with other nutrients in many ways, few, other than those involving  
 116 correction of deficiencies of both Zn and another nutrient, appear to be important in crop  
 117 production. Where interactions do occur, they sometimes result, not from the nutrient to which  
 118 they are attributed, but from other factors associated with the addition of the nutrient compound.  
 119 The results of *kharif* season shows that, N, P and K concentrations in leaves, shoot and kernels  
 120 varied significantly with the foliar application of different sizes and concentrations nanoscale  
 121 ZnO particles.

Comment [ZS16]: Confusing paragraphs!!

123 **References:**

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