Original Research Article

Effects of nano zinc oxide (ZnO) particles on germination of Maize (*Zea Mays* L.) seeds.

Abstract

The Lab experiments was conducted during *kharif* season of 2016-17 in laboratory of Department of Agronomy, Gandhi KrishiVigyana Kendra (G.K.V.K), University of Agricultural Sciences (UAS), Bengaluru with different concentration of nano zinc oxide (800 ppm, 1000 ppm, 1200 ppm 1400 ppm and 1600 ppm) to assess the performance of maize seedling. Among the different concentration of nano zinc oxide 1000 and 1200 ppm recorded 100 percent germination of maize seeds. However, 1200 ppm nano zinc oxide recorded higher root length (6.5 cm), shoot length (3.9 cm) and seed vigor index (1040) compare to other concentrations. Lowest germination were recorded under 1600 nano zinc oxide treatment (40 %).

Key words: Nano ZnO, Maize, Germination, SVI

Introduction:

Maize (*Zea mays* L.) is considered as "Queen of Cereals" because of its high production potential and wider adaptability and it is third most important cereal crop in the world after wheat and rice with an area of 182 million ha, production of 987 million tonnes and productivity of 5423 kg per ha [1]. In India, it is cultivated on an area of 8.55 million ha with a production of 22. 23 million tonnes and the productivity of 2600 kg per ha [1]. In Karnataka, it is cultivated on an area of 1.36 million ha with a production of 4.09 million tonnes with an average productivity of 3018 kg per ha [2].

Nano fertilizers emerging nutrient management tools in agriculture have potential to increase crop yield, nutrient use efficiency and farmer income with reduce environment pollution resulted from application of overdose of fertilizers in crop production. Nano fertilizers have high surface area, water solubility and penetrability which help to increase availability of nutrient to the crop plant from applied surface. Hence, it is visualized as a rapidly evolving field in nutrient management that has potential to revolutionize agriculture and food systems and improve the condition of the poor. Khodakovskaya *et al.* [3] and Ma *et al.* [4] suggested that nanoparticles efficacy depend on their size, surface area, composition and reactivity and interaction with plant surface interact with plants so the impact of engineered nanoparticles (ENPs) on plants physiology and morphology depends on the

composition, concentration, size, and physical and chemical properties of ENPs as well as plant species.

The present study was taken up to investigate the promontory or inhibitory effects of various concentrations of ZnO nanoparticles on germination of maize (*Zea Mays* L.) seeds.

Materials and methods

The Lab experiments wasconducted during *kharif* season of 2016-17 in Petridis. The details of material used and methodology adopted during the course of investigation entitled "effect of nano zinc oxide (ZnO) particles on germination of maize (*Zea mays* L.) seeds". The Lab experiment was conducted in laboratory of Department of Agronomy, Gandhi Krishi Vigyana Kendra (G.K.V.K), University of Agricultural Sciences (UAS), Bangalore - 560 065. Lab experiment was conducted to assess the performance of maize seed treated with different concentration of nanozinc oxide (800 ppm, 1000 ppm, 1200 ppm 1400 ppm and 1600 ppm).

Preparation of Particle Suspensions and Zinc Ion Solution

The nano particles were suspended directly in double distilled water (DDW) and dispersed by using mechanical stirrer for 30 min. Small magnetic bars were placed in the suspensions for stirring before use to avoid aggregation of the particles. Zinc ion (Zn^{2+}) solution was prepared by dissolving zinc sulfate heptahydrate ($ZnSO_4.7H_2O$) in DDW.

Seeds: 10 maize seeds per petridis, observation are recorded after 5 days of treatment with nano zinc oxide solution.

Treatments: 800, 1000, 1200, 1400, 1600 ppm nano zinc oxide, 0.5 % $ZnSO_4.7\ H_2O$ and Deionized distil water.

Vigour index = Root length + Shoot length x Seed germination % [5].

Statistical analysis:

Comment [s1]: In which design? Means were separated by?

Results and Discussion

Among the different concentration of nano zinc oxide 1000 and 1200 ppm recorded 100 percent germination of maize seeds. However, 1200 ppm nano zinc oxide recorded higher root length (6.5 cm), shoot length (3.9 cm) and seed vigor index (1040) compare to other concentrations (Table 1).

Table 1. Effects of nano zinc oxide on seedling growth of the maize

Treatments	Germination %	Root length (cm)	Shoot length (cm)	SVI
1600	40	3.55	2.7	250
1400	90	4.42	2.9	658.8
1200	100	6.5	3.9	1040
1000	100	5.37	2.55	792
800	90	5.35	3.42	789.3
ZnSO4	80	3.37	2.35	457.6
DI Water	60	3.45	3.4	411
CD (P=0.05)	6.81	**0.11**	0.19	6.09

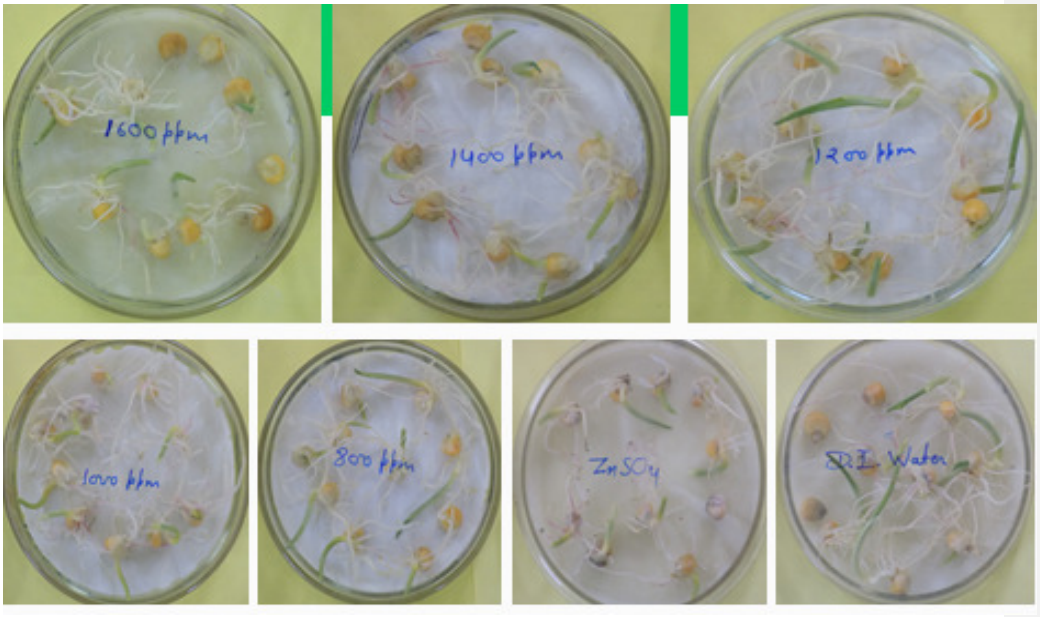

Fig. 1: Effects of different concentration of nanoZnO on moaize seedling 5 days after treatment

Under 1600 ppm nano zinc oxide treatment recorded lowest seed germination percentages, shoot length, root length and SVI compare to other nano zinc oxide concentration it might be due the inhibitory of effect of higher concentration of nano zinc oxide in Petridis on maize seeds result in reduce the germination % and other parameters of maize seedlings. Several research reported that nano zinc oxides increase growth of the plant of different crops like Sedghi *et al.* [6] in soybean,

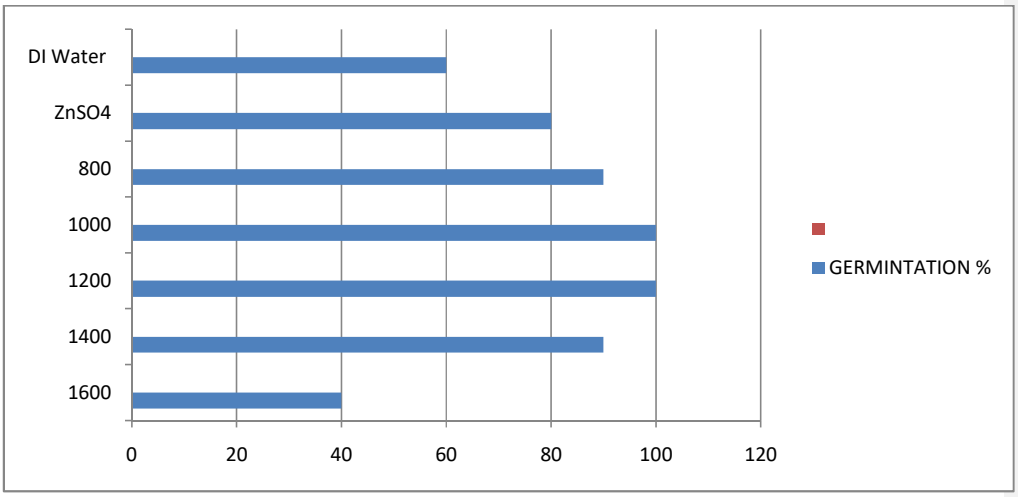

Figure 2: Effects of nano zinc oxide on seed germination of maize

Comment [s2]: Treatments should be in X-axis and germination %, SVI in Y-axis (Fig-2, 3).

Raskarand Laware [7] in onion, Ramesh *et al.* [8] in wheat and Prasad *et al*. [9] in peanut and many studies, increasing evidence suggests that zinc oxide nanoparticles (ZnO NPs) increase plant growth and development. However, higher dose of ZnO nano particles inhibit the germination, growth of the plants which is depend on the concentration of the solution.

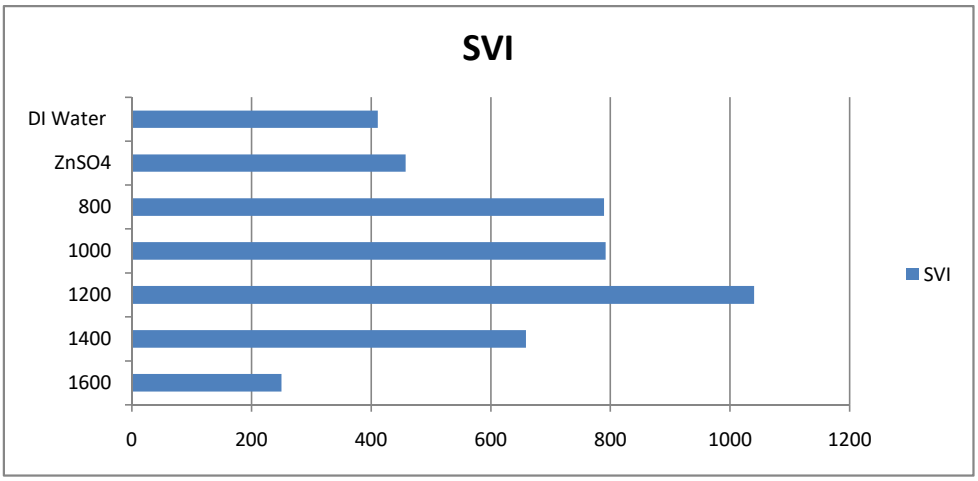

Figure 3: Effects of nano zinc oxide on seed vigor index of maize

Similarly deionised water recorded higher shoot length and root length compare to 0.5 % $ZnSO_4$ and 800 ppm nano ZnO treated Petridis, this might be due to the no inhibitory effect of the solution in case of DI water but due to lack of availability nutrient compare to 1000 & 1200 ppm nano ZnO treatment it reported lower shoot length and root length. Meena Dharam Singh and B. N. Aravinda Kumar [10] and similar results were obtained by Rosa *et al*., applied different concentrations of ZnO nano particles on tomato, alfalfa and cucumber and reported that seed germination was enhanced by nano particles of zinc oxide [11].Meena *et al*., also suggested that nano particles have both positive and negative effects on the plant which is depends on concentration of the solution and type of the crop [12].

CONCLUSION

The salient finding of the experiment indicated that the usefulness and effectiveness of nano ZnO fertilizers to enhance the germination and vigor of the maize seeds. Nanofertilizers perform better under lower concentration but under the situation of high fertilizers dose crop may require higher concentration of nanofertilizers. Overall 1000 and 1200 ppm nano zinc oxide performed well compare to other concentration of nano zinc oxide and control.

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Comment [s3]: Follow the journal style

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