Effects of Nano Zinc Oxide (ZnO) Particles on Germination of Maize (*Zea mays* L.) Seeds

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ABSTRACT

The Lab experimentwas conducted during *kharif* season of 2016-17 inthe laboratory of Department of Agronomy, Gandhi KrishiVigyana Kendra (G.K.V.K), University of Agricultural Sciences (UAS), Bengaluru with different concentrationsof nano zinc oxide (800 ppm, 1000 ppm, 1200 ppm 1400 ppm and 1600 ppm) to assess the performance of maize seedling. Among the different concentrations 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) compared to other concentrations. Lowest germination was recorded under 1600 nano zinc oxide treatment (40 %).

Keywords: Nano ZnO; maize; germination; SVI.

1. INTRODUCTION

Maize (*Zea mays* L.) is considered as "Queen of Cereals" because of its high production potential and wider adaptability and it is the 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 withemerging nutrient management tools in agriculture have potential to increase crop yield, nutrient use efficiency and farmer income with reduced 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 managementwhich has potential to revolutionize agriculture and food systems and improve the conditions of the poor. Khodakovskaya*et al.* [3] and Ma *et al.* [4] suggested that nanoparticles efficacy depends on their size, surface area, composition and reactivity and interaction with plant surface.Theyinteract with plants so the impact of engineered nanoparticles (ENPs) on plants physiology and morphology depends on the

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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.

2. MATERIALS AND METHODS

The Lab experiments wereconducted during *kharif* season of 2016-17 in Petridishes.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 KrishiVigyana 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).

2.1 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 petri dish, observations were 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 %. Abdul-baki and Anderson [5].

3. RESULTS AND DISCUSSION

A lab experiment was conducted by using different concentrationsof nano zinc oxide in laboratory of Department of Agronomy, GKVK, UAS, Bengaluru, Karnataka using Petridishes toassess the effect of nanoZnOon germination of maize seeds. Among the different concentrationsof 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) comparedto other concentrations (Table 1).

Under 1600 ppm nano zinc oxide treatment recorded lowest seed germination percentages, shoot length, root length and SVI compared to other nano zinc oxide concentration it might be due the inhibitory of effect of higher concentration of nano zinc oxide in Petridishesson maize seeds result in reduce the germination % and other parameters of maize seedlings. Several researchersreported that nano zinc oxides increasedgrowth of the plant of different crops like Sedghi*et al.* [6] in soybean, RaskarandLaware [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 ZnOnano particles inhibit the germination, growth of the plants whichdependson the concentration of the solution.

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

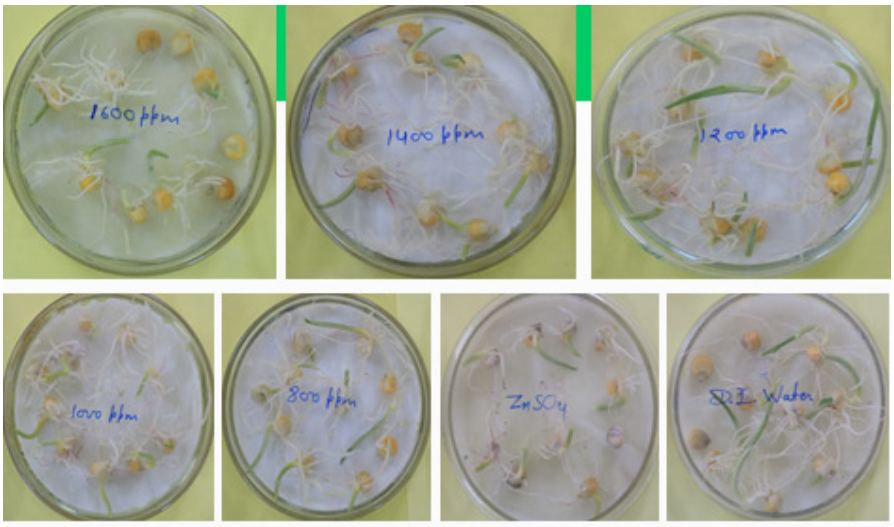

Fig. 1. Effects of different concentration of nanoZnO on maize seedling 5 days after treatment

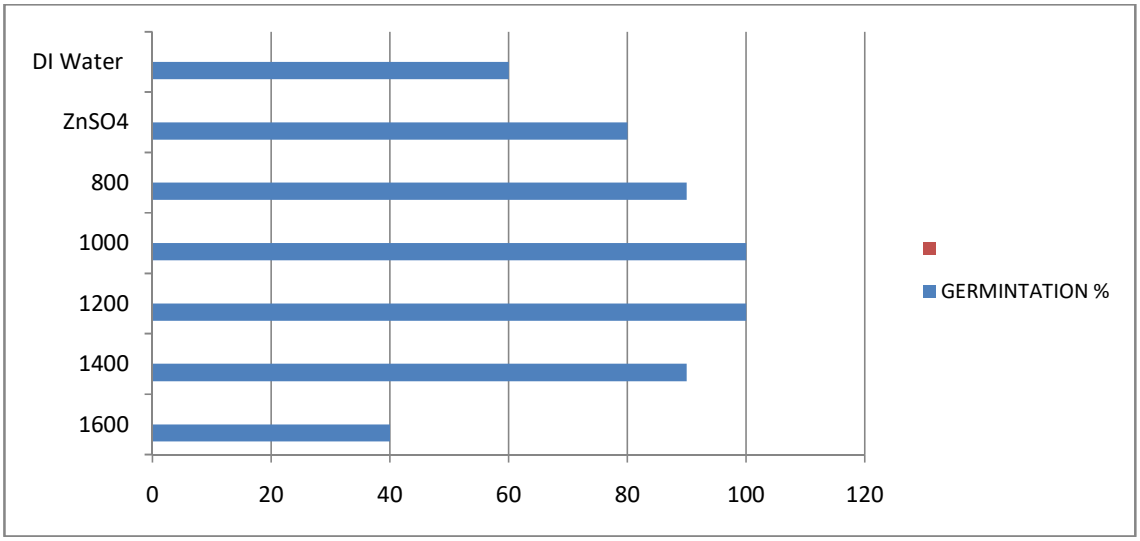

Fig. 2. Effects of nano zinc oxide on seed germination of maize

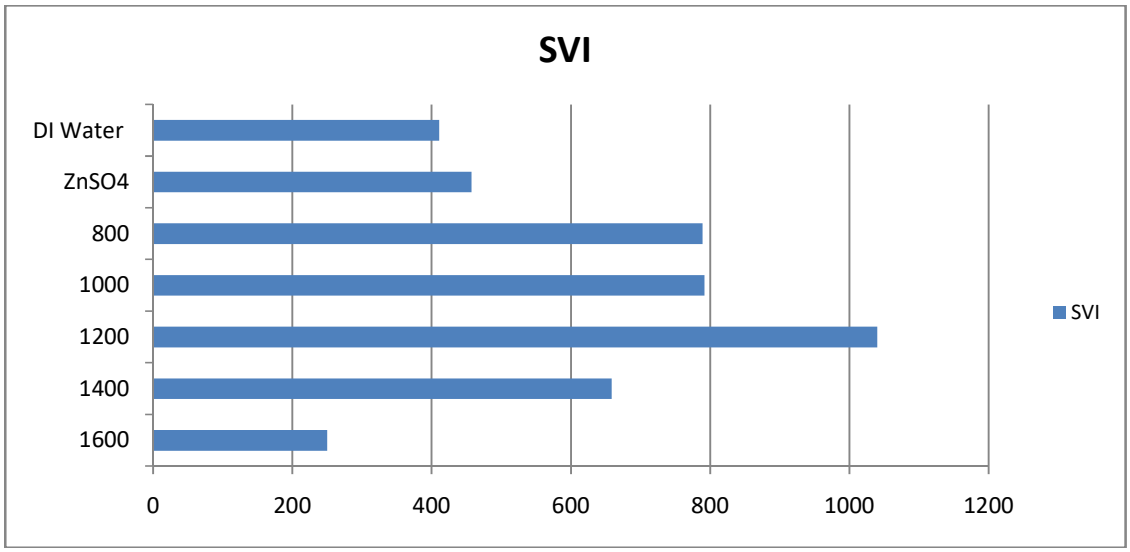

Fig. 3. Effects of nano zinc oxide on seed vigor index of maize

Similarly deionised water recorded higher shoot length and root length compared to 0.5 % $ZnSO_4$and 800 ppm nanoZnO 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 nanoZnO treatment it reported lower shoot length and root length. MeenaDharam Singh and B. N. Aravinda Kumar [10] and similar results were obtained by Rosa *et al*., applied different concentrations of ZnOnano 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 whichdepends on theconcentration of the solution and type of the crop [12].

4. CONCLUSION

The salient findings of the experiment indicatesthat usefulness and effectiveness of nanoZnO fertilizers to enhance the germination and vigor of the maize seeds. Nanofertilizers perform better under lower concentration but under the situation of higher fertilizerdosescrop may require higher concentration of nanofertilizers. Overall 1000 and 1200 ppm nano zinc oxide performed well compared to other concentration of nano zinc oxide and control.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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