



Influence of Seed Priming with Nano Iron Oxide on Germination and Seedling Growth of Mungbean

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Mungbean is one of the important grain legumes and considered as 'Green Pearl' due to its nutritional significance. It is an excellent source of proteins and micronutrients and readily accessible to low income groups in arid and semi-arid regions of Africa and Asia. However, poor nutritional status of the soils in these regions limits the productivity and grain nutritional properties of mungbean. Seed priming with nutrient solutions was identified as viable and cost effective alternative to increase the crop productivity and grain nutritional properties and hence, an *in-vitro* experiment was conducted for optimizing the concentration of nano iron oxide (FeO) for seed priming in mungbean at Agricultural College, Bapatla, Acharya N.G.Ranga Agricultural University, Andhra Pradesh during 2018. Different concentrations of nano iron oxide were tested in completely randomized block design with three replications. The results revealed that, the nano iron oxide 50 ppm was found effective in increasing the germination percent, shoot length, root length, seedling vigour index and speed of germination of mungbean and has been considered as an optimum concentration for seed priming in mungbean.

Keywords: Mungbean; nano iron oxide; biofortification; seed priming; seedling growth.

1. INTRODUCTION

Seed priming is an effective and shotgun approach to improve the emergence and stand establishment of field crops. Studies have proven that the seed priming helps to accelerate and synchronize germination, improve seedling vigour and make the plants more resistant to abiotic and biotic stresses, resulting in improvement of productivity and food quality [1,2,3]. As half of the Indian soils are deficient in micronutrients like zinc and iron, people feeding on the crops grown on these soils have been suffering with micronutrient deficiencies. The micronutrient deficiencies can be corrected through soil application of huge quantities of micronutrient fertilizers. However due to the high cost, difficulty in handling the bulk quantities of fertilizers and also due to the less use efficiency of applied nutrients, soil application has been less preferable. As compared to soil application, foliar application is more effective as it reduces the wastage and improves the use efficiencies of applied fertilizers. However high cost of spraying and timely availability of labour limit the adoptability of even foliar application of micronutrients.

Biofortification through seed, of late has been considered as an effective method which ensures improvement in germination rate, seedling vigour, growth, and development, enhanced tolerance to abiotic and biotic stresses, and increases in crop yield and micronutrient concentration in grains [4,5,6]. Moreover, Seed priming with nutrient solutions was found as an effective method of biofortification as it is inexpensive, simple, and can enhance seed and crop quality for use in resource limited areas [7]. Use of nanofertilizers in agriculture is one of the frontier technologies. Due to smaller particle size and higher surface area, nanofertilizers behave in different manner as compared to corresponding conventional fertilizers. They are highly reactive and can penetrate through cuticle, ensure controlled release and targeted delivery [8] and hence the usage of nano fertilizers through seed priming for biofortification would further enhance the growth, yield and nutritional properties of grains in general and nutritional security in particular.

India is the largest producer of pulses and accounts for about 25 per cent of the global share. Mungbean occupied huge share in total pulse production and contains three times higher protein content than rice [9]. It is less expensive

source of proteins and micronutrients and can be available to all kinds of people. Micronutrient biofortification to the mungbean crop received attention in recent times as it is an effective way in reducing micronutrient malnutrition due to its regular consumption in every day diet. Iron deficiency is more prevalent in India effecting more than 50% of women and children. In order to rapidly reduce the iron deficiency in India, nano iron oxide fertilizer can be used as an effective tool for biofortification in mungbean. However the research in this aspect is very limited and hence the present investigation was planned to identify the optimized concentration for nutrient seed priming with nano iron oxide in mungbean.

2. MATERIALS AND METHODS

An *in-vitro* germination test was conducted with different concentrations of nano iron oxide particles in order to find out the optimum concentration for seed priming in greengram. The experiment was conducted in Research laboratory, Dept. of Agronomy, Agricultural College, Bapatla during 2018 in completely randomized block design with three replications. The treatments include Control, nano iron oxide 50 ppm, nano iron oxide 100 ppm, nano iron oxide 200 ppm, nano iron oxide 500 ppm, nano iron oxide 800 ppm, nano iron oxide 1000 ppm and bulk FeSO_4 5000 ppm.

Healthy and uniform seeds of greengram were selected randomly and placed in petriplates @ 25 per petriplate on sterilized filter paper. Respective concentrations of nano nano iron oxide nutrient solutions were prepared. 5ml of each solution was added to the respective petriplates daily to maintain the moisture for seed germination. Control treatment was maintained with distilled water application. The petriplates were placed in seed germinator at $26 \pm 1^\circ\text{C}$ continuously for seven days. Everyday germinated seeds were counted out of total number of seeds kept in petriplates. Data on root length and shoot length were measured at the end of the experiment. Germination percent, seedling vigour index and speed of germination were calculated by using the following formulas. The data recorded was subjected to statistical analysis.

2.1 Germination Percent

The number of seeds germinated out of 25 were recorded on seventh day and based on

normal seedlings produced; the germination per cent was worked out with the following formula.

$$\text{Germination (\%)} = \frac{\text{Germinated seeds}}{\text{Total number of seeds}} \times 100$$

2.2 Seedling Vigour Index

The length of the shoot and root were taken on seventh day of the experiment and expressed in cm. Seedling vigour index was calculated by the formula described by Abdul-Baki and Anderson [10].

$$\text{SVI} = \text{Germination per cent} \times [\text{Length of the shoot (cm)} + \text{Length of the root (cm)}]$$

2.3 Speed of Germination

Speed of germination was calculated by the following formula given by Czabator [11].

$$\text{Speed of germination} = \frac{n_1}{d_1} + \frac{n_2}{d_2} + \frac{n_3}{d_3} + \dots$$

Where,

n = number of germinated seeds,
d = number of days.

3. RESULTS AND DISCUSSION

The present investigation revealed that, the seed priming with different concentrations of nano iron oxide significantly affected the germination percent, shoot length, root length, seedling vigour index and speed of germination of mungbean. Among all the treatments, the highest germination percent was recorded with nano iron oxide 50ppm, however it was statistically on par with nano iron oxide 100 ppm. Maswada et al. [12] also reported that seed soaking with n-Fe₂O₃ at 10 mg L⁻¹ improved speed and per cent germination, while seed priming with n- Fe₂O₃ at 50 and 100 mg L⁻¹ improved seedling growth in sorghum. In the present study, nano iron oxide 800 ppm and 1000 ppm have recorded lesser germination percent of mungbean as compared to control. Zero germination percent has been found with bulk FeSO₄ 5000 ppm.

Shoot length of mungbean with nano iron oxide 50 ppm and 100 ppm have been found highest whereas shoot length with nano iron oxide 1000 ppm has been found lowest. Shoot length with nano iron oxide 200 ppm and 500 ppm were on par with each other but significantly highest over nano iron oxide 800 ppm. These results are in conformity with that of Karimi et al. [13], who reported higher shoot length of greengram with

Table 1. Effect of different concentrations of nano iron oxide on germination percent, shoot length, root length, seedling vigour index and speed of germination of mungbean

Treatments	Germination per cent **	Shoot length (cm)*	Root length (cm)*	Seedling vigour index	Speed of germination
T ₁ : Control (Distilled water)	68.60 (86.67)	2.49 (5.70)	1.69 (2.34)	696.75	7.08
Nano iron oxide 50 ppm	80.65 (96.00)	2.84 (7.60)	1.98 (3.40)	1056.21	9.33
Nano iron oxide 100 ppm	75.17 (93.33)	2.77 (7.20)	1.77 (2.64)	918.11	8.63
Nano iron oxide 200 ppm	69.88 (88.00)	2.69 (6.73)	1.77 (2.62)	822.87	8.54
Nano iron oxide 500 ppm	69.88 (88.00)	2.65 (6.53)	1.73 (2.49)	793.13	7.28
Nano iron oxide 800 ppm	66.50 (84.00)	2.55 (6.01)	1.69 (2.34)	702.24	7.11
Nano iron oxide 1000 ppm	63.41 (80.00)	2.39 (5.21)	1.60 (2.05)	580.80	7.00
Bulk FeSO ₄ 5000 ppm	0.00 (0.0)	0.71 (0.00)	0.71 (0.00)	0.00	1.87
SEm±	2.22	0.03	0.02	21.70	0.34
CD(P=0.05)	6.65	0.10	0.07	65.06	1.01

() Values in the parenthesis are original values. ** Arcsine transformed values * Square root transformed values

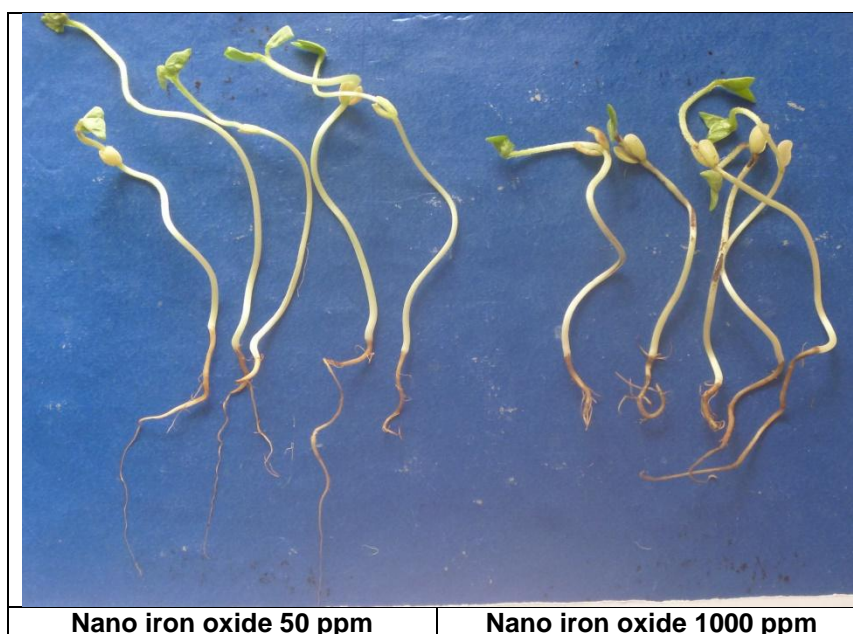


Fig. 1. Root length and shoot length of mungbean as influenced by different concentrations of nano iron oxide

nano Fe-EDDHA @ 50 ppm however with further increase in concentration, reduction in shoot length was noticed. Significantly highest root length of mungbean was observed with nano iron oxide 50 ppm. The root length recorded with nano iron oxide 100 ppm was higher next to 50 ppm but statistically on par with nano iron oxide 200 ppm. With increase in concentration, significant reduction in root length was noticed and the nano iron oxide 1000 ppm reported to have significant reduction in root length as compared to control. Palchoudhury et al. [14] also reported enhanced legume root growth (88–366%) at low concentrations of Fe_2O_3 nano fertilizer.

Seedling vigour index with 50 ppm nano iron oxide was significantly highest among all the treatments tested. The next higher seedling vigour index was recorded with 100 ppm nano iron oxide. Seedling vigour index has been shown considerable reduction with increased concentrations of nano iron oxide and the lowest seedling vigour index was noticed with nano iron oxide 1000 ppm, which was found significantly lowest over control.

Speed of germination with nano iron oxide 50 ppm, 100 ppm and 200 ppm found to be the highest as compared to control and other higher concentrations of nano iron oxide. No germination has been observed with bulk FeSO_4 .

4. CONCLUSION

Based on observations recorded, nano iron oxide 50 ppm found effective in increasing the germination percent, shoot length, root length, seedling vigour index and speed of germination of mungbean and hence it has been considered as optimum concentration for seed priming in mungbean. With increase in concentration, significant reduction in germination percent, shoot and root length were observed.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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