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Meghashree R
M.Sc. Scholar, Department of Seed Science and Technology, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka, India

Chandrashekar SS
Associate Professor, Department of Seed Science and Technology, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka, India

Hilli JS
Dean Agri., College of Agriculture, Hanumanamatti, University of Agricultural Sciences, Dharwad, Karnataka, India

Motagi BN
Senior Scientist, Agricultural Research Station (ARS), Annigeri, University of Agricultural Sciences, Dharwad, Karnataka, India

Corresponding Author:
Meghashree R
M.Sc. Scholar, Department of Seed Science and Technology, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka, India

Effect of green synthesized zinc and iron nanoparticles on seed quality parameters of groundnut (*Arachis hypogaea* L.)

Meghashree R, Chandrashekar SS, Hilli JS and Motagi BN

Abstract
Groundnut (*Arachis hypogaea* L.) is India's important oilseed legume crop. Application of micronutrients through green synthesized nanoparticles is way forward in enhancing seed quality parameters through physiological positive manifestation. The lab experiment was conducted to investigate the effect of green synthesized Zn and Fe nanoparticles on seed quality parameters in groundnut at the Department of Seed Science and Technology, University of Agricultural Sciences, Dharwad. The experiment was laid out in Factorial completely randomized design with three replications and nine treatments. Groundnut varieties (JL-24 and Dh-256) were primed with different concentrations of iron and zinc nanoparticles *i.e.,* Fe NPs (100, 200 and 300 ppm) and Zn NPs (200, 300 and 400 ppm) solutions for the period of 30 min for each concentration. Results revealed that among treatments seeds primed with Zn NPs, 400 ppm for 30 min recorded higher germination percentage (95.52%), shoot length (11.42 cm), root length (16.53 cm) and seedling vigour index I (2670), seedling dry weight (3.86 g), seedling vigour index II (367) and lower electrical conductivity (0.072) as compared to control. Among the varieties, Dh-256 showed higher germination percentage (92.59%), shoot length (9.55 cm), root length (14.93 cm), seedling vigour index I (2274), seedling dry weight (3.39 g), seedling vigour index II (367) and lower electrical conductivity (0.116) as compared to control. Between treatments and varieties for germination percentage, seed and root length and vigour index I & II, seedling dry weight and lower electrical conductivity recorded significant difference.

Keywords: Seed quality, priming with nanoparticles: zinc and iron

Introduction
Groundnut (*Arachis hypogaea* L.) is an important oilseed legume crop in India. It is the fourth and third most important source of edible oil (51%) and vegetable protein (28%), respectively in the world. In calcareous soils of the semi-arid regions of India, the groundnut crop is prone to lime-induced deficiencies of micronutrients such as Fe, Zn and B resulting to maximum yield loss. Generally, to mitigate this problem, seed priming with micronutrients is considered an effective way and is applied in lesser doses, which enhances better germination, seedling emergence, vigour and field emergence. However, the application of micronutrient results were extensive by nature due to the longer duration of the availability of micronutrients to the crops. To mitigate this, an effective way forward for better efficacy and availability of micronutrients to the crops can be achieved through application of green nanoparticles. Green nanoparticles are safer, ecofriendly over chemically and physically synthesized methods. At present application of micronutients through green synthesized nanoparticles is gaining importance and especially in enhancing seed quality parameters through physiological positive manifestation. Hence the present investigation is to evaluate the effect of green synthesized Zinc (Zn) and Iron (Fe) nanoparticle on seed quality of groundnut.

Materials and Methods
The laboratory experiment was conducted to investigate the effect of green synthesized Fe and Zn nanoparticles on seed quality parameters in groundnut varieties JL-24 and Dh-256 during 2022-23 at the Department of Seed Science and Technology, University of Agricultural Sciences, Dharwad. The experiment was laid out in Factorial completely randomized design with 3 replications and 9 treatments *viz.*, For T_1, T_2 and T_3- seeds were primed with Zinc nanoparticles (ZnNPs) of concentration 200, 300 and 400 ppm respectively for 30 min and T_4, T_5 and T_6 – seeds were primed with Iron nanoparticles (FeNPs) of concentration 100, 200 and 300 ppm respectively for 30 min and T_7 and T_8: Seed primed with 1mM $ZnSO_4$ and 1 mM

Fecl$_3$, respectively and T_9 – Hydropriming. The seeds to solutions ratio for nanopriming treatment was 1:2. Later seeds were shade dried to bring down to original moisture content under ambient conditions. Observations on seed quality parameters were recorded. Germination test was conducted in three replications of 50 seeds each by adopating between paper towel methods as described by ISTA procedures (Anon., 2019) [2]. Germination percentage was recorded on the 10th day on the basis of normal seedlings and expressed in percentage. Ten normal seedlings were randomly selected from each of the replication to measure shoot and root length on 10th day of standard germination test and was expressed in centimeter as per metric scale and were kept in a butter paper packet and dried in hot air oven maintained at 80 ± 2 °C for 24 hours, then the seedlings were cooled in desiccators for 30 minutes and the weight of the dry seedlings were recorded using electronic balance and were expressed in grams for computing seedling dry weight. Vigour index was computed by following formula and expressed in number (Abdul-Baki and Anderson, 1973) [1]. For computating the electrical conductivity 5 grams of seeds for each replications of treatments were weighed and soaked in 25 ml distilled water in a beaker and kept at 25 ± 1 °C temperature. After 24 hours of soaking, the solution was decanted and the volume made up to 25 ml by adding distilled water. The electrical conductivity of the seed leachate was measured in the digital conductivity bridge (ELICO) with a cell constant 1.0 and the mean values were expressed in deci simons per meter (dSm^{-1}) (Milosevic *et al*., 2010) [6].

Results and Discussion

Among treatments, the seeds primed with T_3 (Zn NPs at 400 ppm) recorded significantly higher mean germination per cent (95.52%) followed by T_2 (94.15%) and lower (88.07%) in T_9 (Control). In comparison between varieties, V_2 (Dh-256) recorded higher germination per cent (92.59%) as compared to V_1 (JL-24) (91.30%). Between varieties and treatments, V_2 (Dh-256) and T_3 (Zn NPs at 400 ppm) recorded higher germination per cent (96.40%) followed by V_2 and T_2 (Zn NPs at 400 ppm) (95.07%) and lower germination per cent was recorded in V_1 and T_9 (Control) (87.83%) represented in Table 1. This was due to nanoparticles penetration into seed coat pores, cause increased imbition of water molecules and inducing ROS-generating/starch-degrading enzyme activity for physiological enhancement for seed germination (Mahakham *et al*., 2017; Khodakovskaya *et al*., 2011) [5, 4].

The seeds primed with T_3 (Zn NPs at 400 ppm) recorded a significantly higher shoot length (11.42 cm) followed by T_5 (10.52 cm) and lower (5.60 cm) in T_9 (Control). In comparison between varieties, V_2 (Dh-256) recorded higher shoot length (9.55 cm) as compared to V_1 (JL-24) (8.13 cm). Between varieties and treatments, V_2 (Dh 256) and T_3 (Zn NPs at 400 ppm) recorded higher shoot length (12.07 cm) followed by V_2 and T_5 (11.04 cm) and lower shoot length was recorded in V_1 (JL-24) and T_9 (5.17 cm) represented in Table 1. The seeds primed with T_3 (Zn NPs at 400 ppm) recorded a significantly higher root length (16.53 cm) followed by T_2 (15.78 cm), T_5 (15.17 cm) and lower 10.55 cm in T_9 (Control). In comparison between varieties, V_2 (Dh-256) shows a higher root length (14.93 cm) as compared to V_1 (JL-24) (13.87 cm). Between varieties and treatments, V_2 (Dh 256) and T_3 (Zn NPs at 400 ppm) recorded higher root length (17.07 cm) followed by V_2 and T_5 (16.43 cm) and lower root length was recorded in V_1 and T_9 (10.03 cm) represented in Table 2. The probable explanation is that these NPs have a favorable impact on phytohormone reactivity, particularly Indole Acetic Acid (IAA), which is involved in the Phyto stimulatory effects. Zinc-rich ZnO NPs may boost the amount of IAA in roots (sprouts), which in turn hasten up seedling growth. (Pandey *et al*., 2010) [7].

The seeds primed with T_3 (Zn NPs at 400 ppm) recorded a significantly higher seedling vigour index I (2670) followed by T_5 (2431) and is on par with T_2 (2429) and lower (1422) in T_9 (Control). In comparison between varieties, V_2 (Dh-256) recorded higher seedling vigour index I (2274) as compared to V_1 (JL-24) (2014). Between varieties and treatments, V_2 (Dh 256) and T_3 (Zn NPs at 400 ppm) recorded higher seedling vigour index I (2808) followed by V_2 and T_5 (2561) and lower seedling vigour index I was recorded in V_1 and T_9 (1335) represented in Table 2. The seeds primed with T_3 (Zn NPs 400 ppm) recorded significantly higher seedling vigour index II (367) followed by T_5 (341) and is on par with T_2 (341) and lower (237) in T_9 (Control). In comparison between varieties, V_2 (Dh-256) shows a higher seedling vigour index II (314) as compared to V_1 (JL-24) (287). Between varieties and treatments, V_2 (Dh 256) and T_3 (Zn NPs 400 ppm) recorded higher seedling vigour index II (383) followed by V_2 and T_2 (360) and is on par with V_2 and T_5 (354) and lower seedling vigour index II was recorded in V_1 and T_9 (231) represented in Table 3.

The possible explanation for this phenomenon could be that the oxygen generated during this process serves a dual purpose: not only does it support respiration, but it also enhances germination and boosts seedling vigour. Pearson's correlation coefficient analysis indicated a positive linear connection between seed germination and seedling vigour index I & II. This observed correlation may be attributed to the positive impact of Zn NPs on elevating seed quality during the germination stage and quenching the presence of free radicals within the germinating seeds. These findings align with previous research, as demonstrated by Gokak and Taranath (2015) [3], who reported similar results for bulk Zinc at 100 ppm and nano Zinc at 10 and 50 ppm in horse gram seeds, as well as Prasad *et al*. (2012) [8], who observed similar effects for ZnO NPs at 1000 ppm in groundnut seeds.

The seeds primed with T_3 (Zn NPs at 400 ppm) recorded a significantly higher seedling dry weight (3.86 g) followed by T_5 (3.66 g) and is on par with T_2 (3.57 g) and lower (2.69 g) in T_9 (Control). In comparison between varieties, V_2 (Dh-256) shows a higher seedling dry weight (3.39 g) as compared to V_1 (JL-24) (3.13 g). Between varieties and treatments, V_2 (Dh 256) and T_3 (Zn NPs at 400 ppm) recorded higher seedling dry weight (4.03 g) followed by V_2 and T_5 (3.80 g) and is on par with V_2 and T_2 (3.73 g) and lower seedling dry weight was recorded in V_1 and T_9 (2.63 g) represented in Table 3. This might be a result of the seeds food reserves being effectively mobilized, which led to the seedlings rapid emergence and growth. Production of dry matter increased in direct proportion to the growth of the seedlings.

The seeds primed with T_3 (Zn NPs 400 ppm) recorded significantly lower electrical conductivity (0.072) followed by T_5 (0.088) and is on par with T_2 (0.093) and higher (0.255) in T_9 (Control). In comparison between varieties, V_2 (Dh-256) shows a lower electrical conductivity (0.116) as compared to V_1 (JL-24) (0.161). Between varieties and treatments, V_2 (Dh 256) and T_3 (Zn NPs at 400 ppm) recorded lower electrical conductivity (0.062) followed by V_1 and T_3 (0.082) and is on par with V_2 and T_5 (0.083) and higher electrical conductivity was recorded in V_1 and T_9 (0.280) represented in Table 4. According to Sahebi *et al*. (2015) [9], nanoparticles boost the integrity of the plasma membrane by supplying the cell membrane with more stable lipids.

Table 1: Effect of zinc and iron nanoparticles on germination (%) and shoot length (cm) of groundnut varieties

Treatments	Germination (%)			Shoot length (cm)		
	V_1	V_2	Mean	V_1	V_2	Mean
T_1- SP with ZnNPs at 200 ppm for 30 min	90.53 (72.08)*	93.17 (74.85)	91.85 (73.46)	8.30	10.10	9.20
T_2- SP with ZnNPs at 300 ppm for 30 min	93.23 (74.92)	95.07 (77.17)	94.15 (76.04)	9.50	10.53	10.02
T_3- SP with ZnNPs at 400 ppm for 30 min	94.63 (76.61)	96.40 (79.06)	95.52 (77.84)	10.77	12.07	11.42
T_4- SP with FeNPs at 100 ppm for 30 min	91.83 (73.39)	92.40 (74.00)	92.12 (73.70)	7.23	10.27	8.75
T_5- SP with FeNPs at 200 ppm for 30 min	92.07 (73.64)	93.23 (74.92)	92.65 (74.28)	10.00	11.04	10.52
T_6- SP with FeNPs at 300 ppm for 30 min	91.52 (73.07)	93.03 (74.70)	92.28 (73.88)	8.83	10.17	9.50
T_7-SP with 1mM Zinc sulphate for 30 min	90.33 (71.89)	91.20 (72.74)	90.77 (72.32)	6.90	8.03	7.47
T_8-SP with 1mM Iron Chloride for 30 min	89.67 (71.25)	90.52 (72.06)	90.09 (71.66)	6.43	7.73	7.08
T_9- Control (Hydropriming)	87.83 (69.59)	88.30 (70.00)	88.07 (69.79)	5.17	6.03	5.60
Mean	91.30 (72.94)	92.59 (74.39)		8.13	9.55	
	S.Em(±)	C.D (1%)		S.Em(±)	C.D (1%)	
Varieties(V)	0.03	0.12		0.02	0.09	
Treatments(T)	0.07	0.26		0.05	0.18	
V × T	0.10	0.37		0.07	0.26	

*Figures in parenthesis are arc sine transformed values, SP: Seeds Priming, V_1: JL-24, V_2: Dh-256

Table 2: Effect of zinc and iron nanoparticles on root length (cm) and seedling vigour index I of groundnut varieties

Treatments	Root length (cm)			Seedling Vigour Index I		
	V_1	V_2	Mean	V_1	V_2	Mean
T_1- SP with ZnNPs at 200 ppm for 30 min	15.03	14.97	15.00	2112	2335	2223
T_2- SP with ZnNPs at 300 ppm for 30 min	15.53	16.03	15.78	2333	2525	2429
T_3- SP with ZnNPs at 400 ppm for 30 min	16.00	17.07	16.53	2533	2808	2670
T_4- SP with FeNPs at 100 ppm for 30 min	14.20	16.13	15.17	1968	2439	2203
T_5- SP with FeNPs at 200 ppm for 30 min	15.00	16.43	15.72	2301	2561	2431
T_6- SP with FeNPs at 300 ppm for 30 min	14.03	15.83	14.93	2092	2418	2255
T_7-SP with 1mM Zinc sulphate for 30 min	12.70	13.53	13.12	1770	1966	1868
T_8-SP with 1mM Iron chloride for 30 min	12.30	13.27	12.78	1679	1900	1790
T_9- Control (Hydropriming)	10.03	11.07	10.55	1335	1509	1422
Mean	13.87	14.93		2014	2274	
	S.Em(±)	C.D (1%)		S.Em(±)	C.D (1%)	
Varieties	0.01	0.06		5.00	19.23	
Treatment	0.03	0.12		10.60	40.79	
V × T	0.04	0.17		15.00	57.69	

SP: Seeds Priming, V_1: JL-24, V_2 - Dh-256

Table 3: Effect of zinc and iron nanoparticles on seedling dry weight (g /10 seedlings) and seedling vigour index II of groundnut varieties

Treatments	Seedling dry weight (g)			Seedling Vigour Index II		
	V_1	V_2	Mean	V_1	V_2	Mean
T_1- SP with ZnNPs at 200 ppm for 30 min	3.24	3.33	3.29	293	312	303
T_2- SP with ZnNPs at 300 ppm for 30 min	3.41	3.73	3.57	323	360	341
T_3- SP with ZnNPs at 400 ppm for 30 min	3.70	4.03	3.86	348	383	367
T_4- SP with FeNPs at 100 ppm for 30 min	3.25	3.50	3.37	300	323	312
T_5- SP with FeNPs at 200 ppm for 30 min	3.52	3.80	3.66	328	354	341
T_6- SP with FeNPs at 300 ppm for 30 min	3.01	3.20	3.10	275	295	285
T_7-SP with 1mM Zinc sulphate for 30 min	2.73	3.27	3.00	247	298	272
T_8-SP with 1mM Iron chloride for 30 min	2.80	2.91	2.86	251	263	257
T_9- Control (Hydropriming)	2.63	2.74	2.69	230	244	237
Mean	3.13	3.39		288	315	
	S.Em(±)	C.D (1%)		S.Em(±)	C.D (1%)	
Varieties (V)	0.01	0.06		1.45	5.60	
Treatments (T)	0.03	0.13		3.09	11.88	
V × T	0.05	0.19		4.37	16.80	

SP: Seeds Priming, V_1: JL-24, V_2 - Dh-256

Table 4: Effect of zinc and iron nanoparticles on electrical conductivity (dS m^{-1}) of groundnut varieties

Treatments	Electrical conductivity (dS m^{-1})		Mean
	V_1	V_2	
T_1- SP with ZnNPs at 200 ppm for 30 min	0.134	0.092	0.113
T_2- SP with ZnNPs at 300 ppm for 30 min	0.095	0.091	0.093
T_3- SP with ZnNPs at 400 ppm for 30 min	0.082	0.062	0.072
T_4- SP with FeNPs at 100 ppm for 30 min	0.145	0.085	0.115
T_5- SP with FeNPs at 200 ppm for 30 min	0.092	0.083	0.088
T_6- SP with FeNPs at 300 ppm for 30 min	0.164	0.096	0.130
T_7-SP with 1mM Zinc sulphate for 30 min	0.213	0.130	0.172
T_8-SP with 1mM Iron chloride for 30 min	0.243	0.175	0.209
T_9- Control (Hydropriming)	0.280	0.230	0.255
Mean	0.161	0.116	
	S.Em(±)	C.D (1%)	
Varieties(V)	0.001	0.003	
Treatments(T)	0.002	0.006	
V × T	0.003	0.008	

SP: Seeds Priming, V_1: JL-24, V_2 - Dh-256

Conclusion

Seeds primed with nanoparticles recorded higher germination percentage, shoot and root length and seedling vigour index as to compared to hydropriming. The increase in seed quality parameters is due to seed priming with nanoparticles helps in the uptake of water absorption, activates reactive oxygen species (ROS)/antioxidant mechanisms in seeds, forms hydroxyl radicals to loosen the walls of the cells, also acts as an inducer for rapid hydrolysis of starch for better expression of seed quality parameters.

References

1. Abdul-Baki AA, Anderson JD. Vigor determination in soybean seed by multiple criteria Crop science. 1973;13(6):630-633.
2. Anonymous. ISTA-International Rules for Seed Testing. Seed Science and Technology. 2019;29:13-35.
3. Gokak IB, Taranath TC. Seed germination and growth responses of *Macrotyloma uniflorum* (Lam.) Verdc. exposed to zinc and zinc nanoparticles. International Journal of Environmental Sciences. 2015;5(4):840.
4. Khodakovskaya MV, de Silva K, Nedosekin DA, Dervishi E, Biris AS, Shashkov EV, *et al*. Complex genetic, photothermal and photoacoustic analysis of nanoparticle-plant interactions. Proceedings of the National Academy of Sciences. 2011;108(3):1028-1033.
5. Mahakham W, Sarmah AK, Maensiri S, Theerakulpisut P. Nanopriming technology for enhancing germination and starch metabolism of aged rice seeds using photosynthesized silver nanoparticles. Scientific Reports. 2017;7(1):8263.
6. Milosevic M, Vujakovic M, Karagic D. Vigour tests as indicators of seed viability. Genetika. 2010;42(1):103-118.
7. Pandey AC, Sanjay S, Yadav SR. Application of ZnO nanoparticles in influencing the growth rate of *Cicer arietinum*. Journal of Experimental Nanoscience. 2010;5(6):488-497.
8. Prasad TNVKV, Sudhakar P, Sreenivasulu Y, Latha P, Munaswamy V, Reddy KR, *et al*. Effect of nanoscale zinc oxide particles on the germination, growth and yield of peanut. Journal of Plant Nutrition. 2012;35(6):905-927.
9. Sahebi M, Hanafi MM, Siti NAA, Rafii MY, Azizi P, Tengoua FF, *et al*. Importance of silicon and mechanisms of biosilica formation in plants. BioMed Research International. 2015;15:1-16.