International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(1): 176-179

Received: 09-10-2020
Accepted: 17-11-2020

Manish R Pandao
PG Student, Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Maharashtra, India

Mohammad Sajid
Assistant Professor, Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Maharashtra, India

JR Katore
Linseed Agronomist, AICRP on Linseed, College of Agriculture, Nagpur, Maharashtra, India

Sagar S Patil
PG Student, Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Maharashtra, India

Megha B Nirgulkar
PG Student, Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Maharashtra, India

Corresponding Author:
Manish R Pandao
PG Student, Soil Science and Agricultural Chemistry Section, College of Agriculture, Nagpur, Maharashtra, India

Effect of nano zinc oxide on growth, yield and uptake of nutrient by linseed

Manish R Pandao, Mohammad Sajid, JR Katore, Sagar S Patil and Megha B Nirgulkar

DOI: https://doi.org/10.22271/chemi.2021.v9.i1c.11228

Abstract
The research was conducted to investigate the "Effect of nano zinc oxide on growth, yield and fertility status of soil after harvest of linseed" during rabi season 2019-20 at AICRP linseed Farm, College of Agriculture, Nagpur. The experiment was laid out in Randomized Block Design with 7 treatment replicated thrice. The maximum *viz*., Germination (88%), plant stand per plot (635), number of branches plant^{-1} (3.53), number of capsule plant^{-1} (66.87), seed yield kg ha^{-1} (1169), straw yield kg ha^{-1} (2660) and test weight (8.23 g) were found with seed treatment with nano ZnO 1000 ppm. Whereas, pH of soil (7.40), available N in soil (248.83), available K in soil (326.33) and available S in soil (13.83) were recorded higher with soil application of $ZnSO_4$ @ 15 kg/ha + Foliar spray of nano ZnO @ 0.25% at 30 and 45 DAS, EC of soil (0.22) available Zn in soil (0.46) with respect to soil reaction and fertility of soil were recorded higher with seed treatment with nano ZnO 1000 ppm. Organic carbon content (5.9) and available P in soil were recorded higher with soil application of $ZnSO_4$ @ 15 kg/ha + Foliar application of $ZnSO_4$ @ 0.5% at 45 DAS.

Keywords: Nano ZnO, growth, yield, linseed, uptake of nutrient by linseed, fertility status of soil

Introduction
Linseed (*Linum usitatissimum* L.) is one of the oldest crops under cultivation. It belongs to the family *Linaceae* and is native to Mediterranean region and Southwest Asia. The Genus *Linum* has over 200 species of which *Linum usitatissimum* L. is the only economically important species. It has somatic chromosome number 2n=30 and varies from 16 to 86 in other species. It is grown during *rabi* season in India. Two morphologically distinct cultivated species of linseed are recognized, namely flax and linseed. The flax type is commercially grown for the extraction of fibre, whereas the linseed is meant for the extraction of oil from seed. Zinc is one of the essential micro nutrient for plant, and zinc deficiency is common many crops. Zinc is required for the activity of different enzyme, including dehydrogenases, aldolases, isomerases, transphosphorylation, RNA and DNA polymerases and it's also involved in the synthesis of tryptophan, cell division, maintenance of membrane structure and photosynthesis and act as a regulatory cofactor in protein synthesis.

Micronutrient deficiencies in plants may lead to reduced yields and in severe cases, to plant death, also. Among the micronutrients, Zn deficiency is the most detrimental to crop growth and yield of all the cereal crops including wheat [2, 16]. The deficiency of Zn in Indian as well as world soils is very well documented constraint in crop production and since last couple of decades, it is considered to be the 4thmost yield limiting nutrient after N, P, and K, respectively in India [9, 20, 21, 22].

Nano fertilizers are synthesized or modified forms of traditional fertilizers, fertilizers bulk materials or extracted from different vegetative or reproductive parts of the plant by different physical, chemical or biological methods with the help of nanotechnology used to improve soil fertility, productivity and quality of agriculture produce. The main reason for high interest in nano fertilizers is mainly their penetration capacity, size and very high surface area which is usually differ from the same material found in bulk form. Nano fertilizers are eco-friendly and help to reduce environment pollution.

Material and method
The present investigation was carried out during rabi season of the year 2019-20 at AICRP

linseed Farm, College of Agriculture, Nagpur (21^0 10' N and 79^0 4' E, 321.26 m MSL). The climate is hot and slightly moist. The soil of experimental plot was clayey in texture, low in available nitrogen (239.5 kg ha^{-1}), medium in available phosphorus (12.70 kg ha^{-1}), high in available potassium (314.60 kg ha^{-1}), available sulphur in soil (8 kg ha^{-1}), available zinc (0.39 mg kg^{-1}) slightly alkaline in reaction (pH 7.25), EC of soil (0.16dS m^{-1}) and organic carbon content (5.3 g kg^{-1}).

The experiment was laid out to study the Effect of nano zinc oxide on growth, yield and fertility status of soil after harvest of linseed (Variety: PKVNL-260) with Randomize block design which was replicated thrice. The different treatments are as: T_1: Control, T_2: Soil application of $ZnSO_4$ @ 25 kg/ha, T_3: Foliar application of $ZnSO_4$ @ 0.5% at 45 DAS, T_4: Soil application of $ZnSO_4$ @ 25 kg/ha + Foliar application of $ZnSO_4$ @ 0.5% at 45 DAS, T_5: Seed treatment with of nano ZnO 1000 ppm, T_6: Soil application of $ZnSO_4$ @ 15 kg/ha + Foliar spray of nano ZnO @ 0.25% at 30 and 45 DAS, T_7: Foliar application with nano ZnO 0.25% at 30 and 45 DAS and RDF common to all (60: 30: 00 NPK kg ha^{-1}).

Recommended dose of nitrogen *i.e.* 60 kg N ha^{-1} was applied to all treatment in two equal splits, *i.e.* 30 kg basal dose and 30 kg N after 30 DAS *i.e.* top dressing full dose of phosphorus was applied at the time of sowing. $ZnSO_4$ was applied as per treatments. The quantity of the fertilizers was calculated on the basis of percentage of N, P and S content as per requirement of particular treatment.

The fertilizers used *viz.* urea (46% N), Single Super phosphate (SSP) (11% S and 14.5% P). The various biometric observations were recorded treatment wise on randomly selected five linseed plants from each net plot for recording yield parameter during the course of investigation i.e. plant stand per plot, number of branches $plant^{-1}$, number of capsule $plant^{-1}$, seed yield kg ha^{-1}, straw yield kg ha^{-1}, and test weight (g) were recorded on these randomly selected plants. A soil sample was collected randomly from experimental area at a depth of 0-15 cm with the help of screw auger. A composite sample was prepared and sieved through 2 mm sieve and analysed for the estimation of pH, EC, organic carbon content, available nitrogen, phosphorus, potassium, sulphur and zinc content of the soil.

Result and Discussion

Effect of nano ZnO on growth attributes

Data pertaining to germination (%) and plant stand at 30 days as influenced by different treatments is presented in Table 1.

It is revealed that there was slight increase in germination (%) in linseed seed treatment with nano ZnO. Seed treatment with nano ZnO 1000 ppm recorded higher germination (%) (88). However the result were found non-significant. Similar findings were reported by Prasad *et al*., (2012) [18].

Among the different treatments maximum plant stand (635) was recorded in treatment – Seed treatment with nano ZnO (T_5) Boonyanitipong *et al*., (2011) [4] found that the ZnO-NPs at different concentrations did not show any adverse effects on the germination.

Table 1: Effect of nano ZnO on germination (%) and plant stand at 30 days per plot of linseed

Treatments	Germination (%)	Plant stand per plot
T_1	84	628
T_2	85	629
T_3	86	628
T_4	86	627
T_5	88	635
T_6	87	633
T_7	87	630
F-Test	NS	NS
SE(m) ±	1.63	12.72
C.D. at 5%	-	-

Effect of nano ZnO on yield parameters

Data regarding number of branches per plant as influenced by different treatments are presented in table 2. At harvest maximum number of branches per plant (3.53) was recorded in treatment – seed treatment with nano ZnO (T_5) and was found to be statistically at par with treatments T_6 (3.40) and T_7 (3.37). Similar results were found by Jayarambabu *et al*., (2014) [8]. Maximum number of capsules $plant^{-1}$ (66.87) was recorded in treatment – Seed treatment with nano ZnO (T_5) and was found to be statistically at par with treatments T_6 (62.53). Similar results were also reported by Arya and Singh (2000) [3], Kumar *et al*., (2017) [10] and Prasad *et al*., (2012) [18]. Data pertaining to test weight of linseed as influenced by different treatments are presented in table 2. Highest test weight (8.23) was significantly recorded in treatment – Seed treatment with nano ZnO 1000 ppm (T_5) and was found to be statistically at par with treatments T_6 (8.12) and T_7 (8.07). These results were found in agreement with Prasad *et al.*, (2012) [18] and Laware and Raskar (2014) [12]. The data pertaining to seed yield per hectare as influenced significantly by various treatments are presented in table 2. Maximum seed yield ha^{-1} (1169 kg ha^{-1}) was recorded in seed treatment with nano ZnO 1000 ppm (T_5) and was found to be statistically at par with treatments T_6 (1115). The data presented in table 2 revealed that straw yield (kg ha^{-1}) of linseed was influenced significantly due to different nutrient management treatments. Maximum straw yield (2660 kg ha^{-1}) was recorded in treatment with seed treatment with nano ZnO 1000 ppm (T_5) and was found to be statistically at par with treatments T_6 (2515) [17, 8, 18, 1, 25].

Effect of nano ZnO on fertility status of soil after harvest of linseed

The soil pH in different treatment found in the range from 7.28 (T_1) to 7.40 (T_5). The maximum pH (7.40) was recorded in Soil application of $ZnSO_4$ @ 15 kg/ha + Foliar spray of nano ZnO @ 0.25% at 30 and 45 DAS (T_6).

Table 2: Effect of nano ZnO on yield parameter

Treatments	Number of Branches plant^{-1}	Number of capsulePlant^{-1}	Test weight (g) (1000 seed)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1	2.18	46.20	7.70	830	2037
T_2	2.40	54.40	7.81	978	2203
T_3	2.33	51.53	7.90	933	2129
T_4	3.17	60.40	7.99	1063	2317
T_5	3.53	66.87	8.23	1169	2660
T_6	3.40	62.53	8.12	1115	2515
T_7	3.37	61.00	8.07	1082	2419
F-Test	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.11	1.44	0.10	22.19	39.55
C.D. at 5%	0.35	4.44	0.32	68.38	121.88

Table 3: Effect of nano zinc oxide on available nutrient status of soil

Treatments	pH	EC	OC	N	P_2O_5	K_2O	S	Zn
		(dS m^{-1})	(g kg^{-1})	(kg ha^{-1})			(mg kg^{-1})	
T_1	7.28	0.18	5.5	245.50	14.27	318.33	10.00	0.40
T_2	7.30	0.19	5.8	246.00	16.55	319.00	11.17	0.41
T_3	7.29	0.19	5.5	246.68	16.57	322.33	11.50	0.41
T_4	7.36	0.21	5.9	246.90	17.00	324.00	14.17	0.42
T_5	7.38	0.22	5.7	247.33	16.33	324.67	12.33	0.46
T_6	7.40	0.20	5.5	248.83	14.83	326.33	13.83	0.45
T_7	7.38	0.21	5.6	247.17	15.00	324.00	11.67	0.44
F-Test	NS	NS	NS	NS	NS	NS	Sig.	Sig.
SE(m) ±	0.04	0.013	0.16	2.44	0.72	3.56	0.43	0.006
C.D. at 5%	-	-	-	-	-	-	1.34	0.018

The highest EC (0.22) was recorded in seed treatment with nano ZnO 1000 ppm (T_5). it was observed that highest organic carbon content (5.9) was recorded in Soil application of $ZnSO_4$ @ 15 kg ha^{-1} + Foliar application of $ZnSO_4$ @ 0.5% at 45 DAS (T_4) because of increase in biomass of plant as increased in ancillary characters of plant. Similar findings were reported by Du *et al*., (2011) [6]. The available N in soil varied from 245.50 to 248.33 kg ha^{-1}. The highest N content in soil (248.33) was found in Soil application of $ZnSO_4$ @ 15 kg ha^{-1} + Foliar spray of nano ZnO @ 0.25% at 30 and 45 DAS (T_6) [5]. The available P in soil varied from 14.27 to 17.00. The highest P content in soil (17.00) was found in Soil application of $ZnSO_4$ @ 25 kg ha^{-1} + Foliar application of $ZnSO_4$ @ 0.5% at 45 DAS (T_4). Similarly result found by Reetu *et al*. (2019) [19]. The available K in soil varied from 318.33 to 326.33. The highest K content in soil (326.33) was found in Soil application of $ZnSO_4$ @ 15 kgha^{-1} + Foliar spray of nano ZnO @ 0.25% at 30 and 45 DAS (T_6). Similarly result found by Lonergan *et al*., (2009) [14]. The highest S content in soil (14.17) was found in soil application of $ZnSO_4$ @ 25 kg/ha + Foliar application of $ZnSO_4$ @ 0.5% at 45 DAS (T_4) and was found to be statistically at par with treatments T_6 (13.83). Similarly result found by Liu *et al.* (2015) [15]. The highest Zn content in soil (0.46) was found in seed treatment with nano ZnO 1000 ppm (T_5) and was found statistically at par with T_6. Similar findings were reported by Subbaiah (2016) [23].

The results revealed that N uptake by seed (33.32 kg ha^{-1}) and straw (16.32 kg ha^{-1}) of linseed was found significantly higher under the seed treatment with nano ZnO 1000 ppm (T_5). Similarly result found by Fan *et al*., (2012) [7], Van *et al*., (2013) [24]. The data on P uptake revealed that the seed treatment with nano ZnO 1000 ppm (T_5) recorded significantly higher P uptake by seed (9.35 kg/ha) and was found to be statistically at par with treatment T_6 (8.76), in case of seed uptake by linseed. The seed treatment with nano ZnO 1000 ppm (T_5) recorded significantly higher P uptake by straw (5.32 kg ha^{-1}) of linseed and was found to be statistically at par with treatment T_6 (4.77), in case of straw uptake by linseed. Similarly result found by Liang *et al*., (2013) [13]. The seed treatment with nano ZnO 1000 ppm (T_5) had recorded significantly higher K uptake by seed (15.39 kg ha^{-1}) and was found statistically at par with T_6 (14.41) while the seed treatment with nano ZnO 1000 ppm (T_5) gave significantly higher K uptake by straw (9.14 kg/ha) and was found statistically at par with T_6 (8.38). Similarly result found by Ladan *et al*., (2012) [11]. The Significantly higher uptake of Zn by seed (30.40 g/ha) and straw (90.46 g/ha) of linseed was recorded with seed treatment with nano ZnO 1000 ppm (T_5). Similarly result found by Prasad *et al.* (2012) [18], Subbaiah *et al.*, (2016) [23]; Adhikari *et al.*, (2016) [1].

Table 4: Effect of nano zinc oxide on uptake of nutrient by seed and straw of linseed

Treatments	N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})		Zn uptake (g ha^{-1})	
	Seed	straw	Seed	Straw	Seed	Straw	Seed	Straw
T_1	21.86	11.13	6.06	3.32	9.97	5.36	18.27	51.59
T_2	26.26	12.26	7.09	3.81	11.90	6.23	22.47	58.01
T_3	24.51	12.06	7.03	3.47	11.67	6.24	22.09	58.20
T_4	29.09	13.35	8.09	4.01	13.32	7.10	25.48	67.95
T_5	33.32	16.32	9.35	5.32	15.39	9.14	30.40	90.46
T_6	31.31	14.92	8.76	4.77	14.41	8.38	27.86	82.16
T_7	29.94	14.27	8.54	4.43	13.85	7.73	26.15	78.23
F-Test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE(m) ±	0.58	0.23	0.19	0.09	0.44	0.30	0.63	1.19
C.D. at 5%	1.81	0.72	0.60	0.30	1.35	0.93	1.95	3.67

Conclusion

It is concluded that, the application of nano ZnO improve the yield and uptake of nutrients by linseed. Also application of nano ZnO slightly improve the fertility status of soil after harvest of crop but combine application of $ZnSO_4$ and nano ZnO improve the S and Zn status of soil.

Reference

1. Adhikari T, Kundu S, Subba Rao A. Zinc delivery to plants through seed coating with nano-zinc oxide particles. Journal of Plant Nutrition 2016;39(1):136-146.
2. Alloway BJ. Zinc in soils and crop nutrition (2nd edition). Brussels, Belgium: International Zinc Association; and Paris, France: International Fertilizer Industry Association 2008,135.
3. Arya KC, Singh SN. Effect of different levels of phosphorus and zinc on yield and nutrient uptake of maize (*Zea mays* L.) with and without irrigation. Indian Journal of Agronomy 2000;45(4):717-721.
4. Boonyanitipong P, Kositsup B, Kumar P, Baruah B, Dutta J. Toxicity of ZnO and TiO2 nanoparticles on germinating rice seed Oryza Sativa L. International Journal of Bioscience, Biochemistry and Bioinformatics 2011;1(4):282-285.
5. Depar N, Rajpar I, Memon MY, Imtiyaz M, Zia-ul-Hassan. Mineral nutrient densities in some domestics and exotic rice genotypes. Pak J AgricAgrilEng Vet Sci. 2011;27:134-142.
6. Du WC, Sun YY, Ji R, Zhu JG, Wu JC, Guo HY. TiO_2 and ZnO nanoparticles negatively affect wheat growth and soil enzyme activities in agricultural soil. Journal of Environmental Monitoring 2011;13:822-828.
7. Fan L, Wang W, Shao X, Geng Y, Wang Z, Ma Y *et al.* Effects of combined nitrogen fertilizer and nano-carbon application on yield and nitrogen use of rice grown on saline-alkali soil.Journal of Food, Agriculture & Environment 2012;10(1):558-562.
8. Jayarambabu M, Sivakumari B, Rao KV, Prabhu YT. Germination and growth characteristics of mungbean seeds affected by synthesized ZnO nanoparticles. International Journal of Current Engineering and Technology 2014;4:3411-3416.
9. Katyal JC, Sharma BD. DTPA-extractable and total Zn, Cu, Mn and Fein Indian soils and their association with some soil properties. Geoderma 1991;49:165-179.
10. Kumar JU, Bahadur V, Prasad VM, Mishra S, Shukla PK. Effect of Different Concentrations of Iron Oxide and Zinc Oxide Nanoparticles on Growth and Yield of Strawberry (*Fragariaxananassa Duch*) cv. Chandler. Int. J. Curr. Microbiol. App. Sci 2017;6(8):2440-2445.
11. Ladan MA, Vattani H, Baghaei N, Keshavarz N. Effect of different levels of fertilizer nano iron chelates on growth and yield characteristics of two varieties of spinach (*Spinaciaoleracea* L.): varamin 88 and viroflay. Research Journal of Applied Sciences, Engineering and Technology 2012;4(12):4813-4818.
12. Laware SL, Raskar S. Influence of zinc oxide nanoparticles on growth, flowering, and seed productivity in onion. International Journal of Current Microbiology and Applied Sciences 2014;3(7):874-881.
13. Liang TB, Yin QS, Zhang YL, Wang BL, Guo WM, Wang JW *et al*. Effects of carbon nanoparticles application on the growth, physiological characteristics and nutrient accumulation in tobacco plants. Journal of Food, Agriculture and Environment 2013;11:954-958.
14. Lonergan PF, Pallota MA, Lorimer M, Paull JG, Barker SJ, Graham RD. Multiple genetic loci for Zn uptake and distribution in barley (*HordeumVulgare)*. New Phytol 2009;184:168-179.
15. Liu X, Wang F, Shi Z, Tong R, Shi X. Bioavailability of Zn in ZnO nanoparticle-spiked soil and the implications to maize plants. The Journal of Nanoparticle Research 2015;17:175-185.
16. Marschner H. Mineral Nutrition of Higher Plants (2nd Ed.) Academic Press, London 1995,889p.
17. Pandey AC, Sanjay SS, Yadav RS. Application of ZnO nanoparticles in influencing the growth rate of *Cicerarietinum*. Journal of Experimental Nanoscience 2010;5(6):488-497.
18. Prasad TNVKV, Sudhakar P, Sreenivasulu Y, Latha P, Munaswamy Y, Raja Reddy K *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.
19. Reetu B, Anu K, Salwinder SS. Evaluation of efficacy of ZnO nanoparticles as remedial zinc nanofertilizer for rice. Journal of Soil Science and Plant Nutrition 2019.
20. Shukla AK, Tiwari PK, Prakash C. Micronutrients deficiencies vis-a-vis food and nutritional security of India. Indian Journal of Fertilisers 2014;10:94-112.
21. Sillanpaa M. Micronutrient assessment at the country level: an international study. FAO Soils Bulletin 63.FAO/Finnish International Development Agency, Rome, Italy 1990.
22. Singh MV. Micronutrient nutritional problems in soils of India and improvement for human and animal's health. Indian Journal of Fertilizers 2009;5(4):11-26.
23. Subbaiah LV, Prasad TNVKV, Krishna TG, Sudhakar P, Reddy BR, Pradeep T. Novel effects of nanoparticulate delivery of zinc on growth, productivity, and zinc biofortification in maize (*Zea mays* L.). Journal of Agricultural and Food Chemistry. 2016;64(19):3778-3788.
24. Van NS, Minh HD, Dzung NA. Study on chitosan nanoparticles on biophysical characteristics and growth of Robusta coffee in green house. Biocatalysis and Agricultural Biotechnology 2013;2:289–294.
25. Yang Z, Chen J, Dou R, Gao X, Mao C, Wang L. Assessment of the phytotoxicity of metal oxide nanoparticles on two crop plants, maize (*Zea mays* L.) and rice (*Oryza sativa* L.). International Journal of Environmental Research and Public Health 2015;12:15100-15109.