Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(4): 1266-1269
Received: 01-05-2017
Accepted: 02-06-2017

Ambily Elizabath
Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh, India

Vijay Bahadur
Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh, India

Pragathi Misra
Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh, India

Vipin Mashi Prasad
Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh, India

T Thomas
Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh, India

Correspondence
Ambily Elizabath
Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh, India

Effect of different concentrations of iron oxide and zinc oxide nanoparticles on growth and yield of carrot (*Daucus carota* L.)

Ambily Elizabath, Vijay Bahadur, Pragathi Misra, Vipin Mashi Prasad and T Thomas

Abstract
The field experiment was carried out at Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, India during Rabi season (Nov-April) 2016-17. The experiment was laid out in 4×4 factorial randomized block design with 16 treatments in three replications. It is concluded that the best yield attributes in namely, plant height (cm) (91.24 cm), number of leaves/plant (12.47), petiole length/plant (cm) (13.38cm), and leaf area (cm^2) (75.73cm^2), root diameter (cm) (3.53cm), root length (cm) (19.75cm), root yield/treatment (kg) (72.33kg) and root yield/hectare (t/ha) (29.41 tones/ha) in T_8 (Z_2F_1: ZnO NPs @100ppm + FeO NPs @50ppm), and also concluded that the best cost benefit ratio 2.02, was obtained T_8 (Z2F1: ZnO NPs @ 100ppm + FeO NPs @ 50ppm).

Keywords: Zinc oxide, iron oxide nanoparticles, growth, yield parameters

Introduction
The increasing world population has led to increases in food production. To increase food production it is necessary to use the different technologies in agriculture. Nanotechnology can be used as an alternative technology in a wide scientific area. Nanotechnology has been described as relating to materials, systems and processes which operate at a scale of 100 nanometres or less (Mousavi and Rezai 2011, Srilatha 2011, Ditta 2012) [10, 18, 3]. Nanotechnology provides a lot of benefit in the area of pollution sensing and prevention, by exploiting novel properties of nanomaterials (Baruah and Dutta 2009, Srilatha 2011) [1, 18].
Nanoparticles interact with plants causing many morphological and physiological changes, depending on the properties of NPs. Efficacy of NPs is determined by their chemical composition, size, surface covering, reactivity, and most importantly the dose at which they are effective (Khodakovskaya *et al.,* 2012) [7]. Researchers from their findings suggested both positive and negative effects on plant growth and development, and the impact of engineered nanoparticles (ENPs) on plants depends on the composition, concentration, size, and physical and chemical properties of ENPs as well as plant species. Efficacy of NPs depends on their concentration and varies from plants to plants. Review covers plausible role NPs in seed germination, roots, plant growth (shoot and root biomass) and photosynthesis.
In many studies, increasing evidence suggests that zinc oxide nanoparticles (ZnO NPs) increase plant growth and development. Prasad *et al.,* (2012) [11] in pea-nut; Sedghi *et al.,* (2013) [15] in soybean; Ramesh *et al.,* (2014) [13] in wheat and Raskar and Laware (2014) [14] in onion reported that lower concentration of ZnONPs exhibited beneficial effect on seed germination. However, higher dose of ZnO NPs impaired seed germination. The effect of NPs on germination depends on concentrations of NPs and varies from plants to plants. (De Rosa *et al.,* 2013) [2] applied different concentrations of ZnO NPs on cucumber, alfalfa and tomato, and found that only cucumber seed germination was enhanced. (Raliya and Tarafdar 2013) [12] reported that ZnO NPs induced a significant improvement in Cyamopsis tetra gonoloba plant biomass, shoot and root growth, root area, chlorophyll and protein synthesis, rhizospheric microbial population, acid phosphatase, alkaline phosphatase and phytase activity in cluster bean rhizosphere. It is evident from the correlative light and scanning microscope, and inductive coupled plasma/atomic emission spectroscopy that seedling roots of Vigna radiata and Cicer arietinum absorbed ZnO NPs and promoted the root and shoot length, and root and shoot biomass (Mahajan *et al.,* 2011) [9]. Nano ZnO supple-mented with MS media promoted somatic embryogenesis, shooting, regen-eration of plantlets, and also induced proline

synthesis, activity of superoxide dismutase, catalase, and peroxidase thereby improving tolerance to biotic stress (Helaly *et al.,* 2014) [6].
Nano iron oxide at the concentration of 0.75g/L increased leaf + pod dry, weight and pod dry weight. The highest grain yield was observed by using 0.5g/L nano iron oxide that showed 48% increase in grain yield in comparison with control. Other measured traits were not affected by the iron nanoparticles. TreamentS were five levels of nano-iron oxide (0, 0.25, 0.75 & 1 g/L) (Sheykhbaglou *et al.,* 2010) [16].
There are insufficient studies on nanoparticles produced with nanotechnology, although we know it has significant impact in agricultural production. The aim of this study was to determine that the effects of nanotechnology liquid nanoparticles on the plant growth, yield and quality of carrot (*Daucus carota* L.).

Materials and Methods
Carrot (*Daucus carota* L. cv. Pusa Rudhira) was used as the plant material and planted in 3 replications with spacing of 30x10cm and conducted in Randomized Block Design. Iron Oxide (FeO) and Zinc Oxide (ZnO) nanoparticles were used in this study as foliar application. Nanoparticles interact with plants causing many morphological and physiological changes, depending on the properties of NPs. Efficacy of NPs is determined by their chemical composition, size, surface covering, reactivity, and most importantly the dose at which they are effective (Khodakovskaya *et al.,* 2012) [7].
Treatments used in the study are: Control (none treatment), Z1:50ppm, Z2:100ppm, Z3:150ppm, F1:50ppm, F2:100ppm, F3:150ppm, Z_1 F_1 (50ppm ZnO NPs + 50ppm FeO NPs), Z2 F1 (100ppm ZnO NPs + 50ppm FeO NPs), Z3 F1 (150ppm ZnO NPs + 50ppm FeO NPs), Z1 F2 (50ppm ZnO NPs + 100ppm FeO NPs), Z2 F2 (100ppm ZnO NPs + 100ppm FeO NPs), Z3 F2 (150ppm ZnO + 100ppm FeO), Z1F3 (50ppm ZnO NPs + 150ppm FeO NPs), Z2F3 (100ppm ZnO NPs + 150ppm FeO NPs) and Z3F3 (150ppm ZnO NPs + 150ppm FeO NPs). Growth and yield parameters plant height, no. of leaves, petiole length was, and leaf area, root diameter, root length, root yield/plot, root yield/treatment and root yield/hectare were recorded and analised.
Iron Oxide (FeO) and Zinc oxide (ZnO) nano-particules were prepared in Department of Nanotechnology, SHUATS, Allahabad, UP. FeO or ZnO nanoparticles or were prepared by dissolving 0.1M Ferrous sulphate or Zinc sulphate (FeSO4 for ironoxide and ZnSO4 for zincoxide) in 25 ml of distilled water, then 0.1MPEG was added to the mixture solution of 25ml of 0.2M Sodium hydroxide and 0.1ML OF 0.1M sodium borohydride was added to the mixture under vigorous stirring at room temperature, black in the case of FeO white in the case of ZnO precipitate were obtained. The precipitate was then washed with distilled water and finally dried in vaccum oven at 70^0c. The sample was stored in distilled water. The concentration of the nanoparticles obtained was calculated by differential weight analysis.
Data analysis: The data recorded were subjected to statistical analysis as per the method suggested by.

Results and Discussion
The effect of nanotechnology liquid fertilizer on total growth attributes and yield are shown in Table 1, such as plant height (cm), number of leaves, petiole length(cm), leaf area (cm^2), root diameter (cm), root length (cm), root yield/treatment (kg) and root yield/hectare (t/ha). Nanotechnology liquid fertilizers significantly (ZnO NPs @ 100ppm + FeO NPs @ 50ppm) affected the growth, yield and quality of carrot statistically. While the highest, plant height (91.24 cm), no. of leaves (12.47), petiole length (13.38cm^2), and leaf area (75.73cm), (Table 1), root diameter (3.53cm), root length (19.75cm), root yield/treatment (72.33kg) and root yield/hectare (29.41 tones/ha) obtained in T8 (Z_2F_1: ZnO NPs @100ppm + FeO NPs @50ppm), The lowest yield was obtained from the control in all treatments that are given.
In the case of growth attributes, maximum plant height (cm) *i.e.* 38.75, 88.29, and 91.41 cm were observed in T8 (Z_2F_1: ZnO NPs @ 100ppm + FeO NPs @ 50ppm), followed by 37.80cm in T3 (Z_3 :ZnO NPs @150ppm) and 36.78cm in T4 (F_1:FeO NPs @50ppm), 87.15cm in T9 (Z_3F_1:150ppm ZnO NPs +50ppm FeO NPs) and 86.86cm in T1(Z_1:ZnO NPs @50ppm), 91.41cm in T1(Z_1:ZnO NPs @50ppm) and 90.43cm in T6 (F_1:FeO NPs @150ppm) which was significantly superior to rest of the treatments, while the minimum plant height (cm) *i.e.* 33.17, 84.31and 87.24cm was recorded in T_0 (Control). The maximum number of leaves per plant *i.e.* 8.47, 13.07, and 12.47 were observed in T8 (Z_2F_1: ZnO NPs @ 100ppm + FeO NPs @ 50ppm), followed by 8.27 in T3 (Z_3:ZnO NPs @150ppm) and 7.67 in T5 (F2:FeO NPs @100ppm), 12 in T9 (Z_3+F_1 :ZnO NPs @150ppm+FeO NPs @50ppm) and 11.93 in T3 (Z_3:ZnO NPs @150ppm), 12 in T9 (Z_3+F_1 :ZnO NPs @150ppm+FeO NPs @50ppm) and 11.87 in T3 (Z_3:ZnO NPs @150ppm), which were significantly superior to rest of the treatments, while the minimum number of leaves *i.e.* 6.93, 10.00 and 10.00 was recorded in T_0 (Control). The maximum petiole length (cm) *i.e.*8.50, 13.40 and 13.88 cm were observed in T8 (Z_2F_1: ZnO NPs @ 100ppm + FeO NPs @ 50ppm), followed by 8.33cm in T3 (Z_3:ZnO NPs @150ppm) and 8.21cm in T5 (F_2:FeO NPs @50ppm), 13.09cm in T3 (Z_3:ZnO NPs @150ppm) and 13.03cm in T14(Z_2F_3:ZnO NPs @100ppm + FeO NPs @150ppm) and 13.59cm in T1(Z_1: ZnO NPs @50ppm) and 13.35cm inT15 (Z_3F_3:ZnO NPs @150ppm + FeO NPs @150ppm) which was significantly superior to rest of the treatments, while the minimum petiole length (cm) *i.e.*7.59, 12.29 and 12.79 cm was recorded in T_0 (Control). The maximum leaf area (cm^2) *i.e.*68.99, 74.43 and 75.73 cm^2 were observed in T8 (Z_2F_1: ZnO NPs @ 100ppm + FeO NPs @ 50ppm), followed by 68.87cm^2 in T11 (Z_2F_2:ZnO NPs @50ppm + FeO NPs @50ppm) and 68.25cm^2 T3 (Z_3:ZnO NPs @150ppm), 73.10cm^2 in T14 (Z_2F_3:ZnO NPs @100ppm + FeO NPs @150ppm) and 75.59cm^2 in T11 (Z_2F_2:ZnO NPs @50ppm + FeO NPs @50ppm), 74.83cm^2 T5(F_2:FeO NPs @100ppm) and 74.27cm^2 in T3 (Z_3:ZnO NPs @150ppm), which was significantly superior to rest of the treatments, while the minimum leaf area (cm^2) *i.e.*58.00, 64.25 and 66.15 cm^2 was recorded in T_0 (Control).

Table 1: Effect of Iron oxide and Zinc oxide nanoparticles on growth and yield of carrot (*Daucus carota* L.)

Treatments	Plant height (cm)	No. of leaves/Plant	Petiole length (cm)	Leaf area (cm^2)	Root diameter (cm)	Root length (cm)	Root yield/treatment (kg)	Root yield/hectare (t/ha)
T_o	87.24	10	12.79	65.15	2.4	14.81	55	24.25
T_1	91.24	11.2	13.59	72.39	2.6	15.61	57.67	26.43
T_2	88.08	9.67	13.11	71.02	2.53	15.53	60.33	26.3
T_3	89.51	11.87	12.93	74.27	2.6	16.13	58.67	26.57
T_4	87.72	10.58	13.31	72.39	2.5	18.83	55.67	26.11
T_5	90.29	11.07	13.2	74.83	2.53	17.82	55.67	26.15
T_6	90.43	11.2	13.04	71.03	2.5	17.8	57.33	24.97
T_7	90.17	9.67	12.99	71.25	2.5	15.25	57	24.87
T_8	91.41	12.47	13.88	75.73	3.53	19.75	72.33	29.41
T_9	89.02	12	13.53	69.43	2.73	15.07	60.67	20.6
T_{10}	87.89	10.4	13.37	69.53	2.57	16.15	57.33	26.35
T_{11}	89.07	11.13	13.21	73.2	2.43	17.7	56	25.4
T_{12}	88.24	11.4	13.11	73.02	2.53	16.2	63.67	23.33
T_{13}	87.63	10.27	13.27	68.81	2.6	15.85	61.67	25.35
T_{14}	89.33	10.8	13.67	72.08	2.7	14.1	57.33	26.04
T_{15}	88.16	11.67	13.55	67.59	2.63	17.01	60.67	24.95
F-test	S	S	S	S	S	S	S	S
S. Em. (±)	0.46	0.1	0.13	1.47	0.08	2.06	2.33	1.68
C.D. at 5%	0.95	0.21	0.26	3.01	0.17	4.21	4.76	3.43

Sheykhbaglou *et al.,* (2010) [16] experiment was conducted that nano iron oxide at the concentration of 0.75g L^{-1} increased leaf + pod dry weight and pod dry weight. The highest grain yield was observed by using 0.5g L^{-1}nano iron oxide that showed 48% increase in grain yield in comparison with control. Other measured traits were not affected by the iron nanoparticles. Treatments were five levels of nano iron oxide (0, 0.25, 0.75& 1 g L^{-1}), and also some similar result were observed by Prasad *et al*., (2012) **[11]** experiment was conducted that peanut seeds were separately treated with different concentrations of nano scale zinc oxide (ZnO) and chelated bulk zinc sulfate (ZnSO4) suspensions (a common zinc supplement), respectively and the effect this treatment had on seed germination, seedling vigor, plant growth, flowering, chlorophyll content, pod yield and root growth were studied Treatment of nano scale ZnO (25 nm mean particle size) at1000ppmconcentration promoted both seed germination seedling vigor and in turn showed early establishment in soil manifested by early flowering and higher leaf chlorophyll content. These particles proved effective in increasing stem and root growth. Pod yield per plant was 34% higher compared to chelated bulk ZnSO4.

In the case of yield attributes, maximum root diameter (cm) *i.e.*3.53cm were observed in T8 (Z_2F_1: ZnO NPs @ 100ppm + FeO NPs @ 50ppm), followed by 2.73cm in T9 (Z_3F_1: ZnO NPs @150ppm + FeO NPs @50ppm) and 2.70cm in T14 (Z_2F_3: ZnO NPs @100ppm + FeO NPs @150ppm), which was significantly superior to rest of the treatments, while the minimum average root diameter (cm) *i.e.*2.43cm was recorded in T_0 (Control). The maximum root length (cm) *i.e.* 19.75 cm were observed in T8 (Z_2F_1: ZnO NPs @100ppm + FeO NPs @50ppm), followed by 18.83cm in T4 (F_1: FeO NPs @50ppm) and 17.82 in T5 (F_2: FeO NPs @100ppm) which was significantly superior to rest of the treatments, while the minimum root length (cm) *i.e.* 14.81cm was recorded in T_0 (Control). The maximum root weight per treatments *i.e.*72.33kg were observed in T8 (Z_2F_1: ZnO NPs @ 100ppm + FeO NPs @ 50ppm), followed by 63.67kg in T12 (Z_3F_2: ZnO NPs @ 150ppm + FeO NPs @ 100ppm) and 60.67kg in T15 (Z_3F_3: ZnO NPs @ 150ppm + FeO NPs @ 150ppm), which was significantly superior to rest of the treatments, while the minimum root weight per treatments *i.e.*55.00kg was recorded in T_0 (Control). The maximum root yield per hectare *i.e.* 29.41t/ha were observed in T8 (Z_2F_1: ZnO NPs @ 100ppm + FeO NPs @ 50ppm), followed by 26.57t/ha T3 (Z_3: ZnO NPs @ 150ppm) and 26.43t/ha in T1 (Z_1: ZnO NPs @50ppm) which was significantly superior to rest of the treatments, while the minimum root yield per hectare *i.e.* 24.25t/ha was recorded in T_0 (Control).

The result of this study showed that nanotechnology liquid fertilizer (Zinc oxide and Iron oxide) treatment increased the parameters of plant yield and growth compared to the control in carrot. There are insufficient studies on fertilizers produced with nanotechnology, although nowadays it is known to have a significant impact in agricultural production. It was reported that nanoparticles applications as foliar can be increased 25–45% in the number of tomato fruit and flowers (Ferbanat 2013) [5].

The Interaction effect of ZnO and FeO on Plant height of carrot was also found significant. It is generally beneficial for root and shoots growth of plants, increasing cell permeability and supply plant nutrients. Similar result were observed by Tyagi *et al.* (2016) [17]. The higher dose of nitrogen might have enhanced cell division and formation of more tissues resulting in luxuriant vegetative growth and thereby increased plant height and Similar result were observed by.

Nitrogen, which is one of the most important nutrients in agricultural production, might be given only very few parts to plant and soil need, although it has been reported that the use of very small nanofertilizer particles is more effective than this rate (De Rosa *et al*. 2010) [2]. This effect is also provided with other plant nutrients. The nutrients which are available for the plant can be encapsulated in nanomaterials (nanotubes or nanoporous materials), coated with thin protective polymer film or added as particles or emulsions of nanoscale (De Rosa *et al*. 2010, Srilatha 2011, Ditta 2012) [2, 18, 3]. As a result of this study it can be expressed that the fertilizer used in this study showed this effect and becomes available for cucumber plants.

Conclusion

The nanomaterial is one of the new technologies that into almost all areas of our lives and being to be used in agriculture production. The researchers indicate many of the potential benefits of nanotechnology. Considering the present investigation, it may be concluded in combination of Zno and FeO nanoparticles T8 (Z_2F_1: ZnO NPs @ 100ppm + FeO NPs @ 50ppm), on vegetative growth, yield and biochemical was found to be the best and in terms of maximum. This study has identified that fertilizers can have important effective on the plant growth, yield and quality of carrot.

Acknowledgment
Authors are sincerely thankful to SHUATS, for taking interest and encouragement to carried out the research work at Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, India

References
1. Baruah S, Dutta J. Nanotechnology applications in pollution sensing and degradation in agriculture: A Review. Environ. Chem. Lett. 2009; 7(3):191-204.
2. De Rosa MC, Monreal C, Schnitzer M, Walsh R, Sultan Y. Nanotechnology in fertilizers. Nat. Nanotechnol. 2010; 5(2):91.
3. Ditta A. How helpful is nanotechnology in agriculture? Adv. Nat. Sci.: Nanosci. Nanotechnol. 2012; 3:10.
4. Ekinci M, Dursun A, Yıldırım E, Parlakova F. The effects of nanotechnological liquid fertilizers on plant growth and yield in tomato. 9. Ulusal Sebze Tarımı Sempozyumu, 2012; 326-329, 14-12.
5. Ferbanat L, 2013. http://www.ferbant.com/, December.
6. Helaly MN, El-Metwally MA, El-Hoseiny H, Omar SA, El-Sheery NI. Effect of nano-particles on biological contamination of *in vitro* cultures and organ genic regeneration of banana. Aust J Crop Sci. 2014; 8:612-624.
7. Khodakovskaya MV, de Silva K, Biris AS, Dervishi E, Villagarcia H. Carbon nanotubes induce growth enhancement of tobacco cells. ACS Nano., 2012; 6(3):2128-2135.
8. Laware SL, Shilpa R. Influence of Zinc Oxide Nanoparticles on Growth, Flowering and Seed Productivity in Onion, Int. J. Curr. Microbiol. App. Sc. i, 2014; 3(7):874-881.
9. Mahajan P, Dhoke SK, Khanna AS. Effect of nano-ZnO particle suspension on growth of mung (Vigna radiata) and gram (Cicer arietinum) seedlings using plant agar method. J Nanotechnol. 2011, 1-7.
10. Mousavi SR, Rezaei M. Nanotechnology in agriculture and food production. J. Appl. Environ. Biol. Sci. 2011; 1(10):414–419.
11. Prasad TNVKV, Sudhakar P, Sreenivasulu Y, Latha P, Munaswamy V, Reddy KR *et al*. Effect of nanoscale zinc oxide particles on the germina-tion, growth and yield of peanut. *J Plant Nutr.* 2012; 35(6):905-927.
12. Raliya, Tarafdar. ZnO Nanoparticle Biosynthesis and Its Effect on Phosphorous-Mobilizing Enzyme Secretion and Gum Contents in Clusterbean (*Cyamopsis tetragonoloba* L.) J. C. Agric Res. 2013; 2(1):48-57
13. Ramesh M, Palanisamy K, Babu K, Sharma NK. Effects of bulk & nano-titanium dioxide and zinc oxide on physio-morphological changes in Triticum aestivum Linn. J Glob Biosci. 2014; 3:415-422.
14. Raskar SV, Laware SL. Effect of zinc oxide nanoparticles on cytology and seed germination in onion. Int. J. Curr. Microbiol. App. Sci. 2014; 3(2):467-473
15. Sedghi M, Hadi M, Toluie SG. Effect of nano zinc oxide on the germination of soybean seeds under drought stress. Ann West Uni Timis¸ oara ser Biol XVI., 2013; 2:73-78.
16. Sheykhbaglou R, Sedghi M, Tajbakhsh Shishevan M, Seyed Sharifi R. Effects of Nano-Iron Oxide Particles on Agronomic Traits of Soybean. Not Sci. Biol. 2010; 2(2):112-113.
17. Shruti Tyagi. Effects of Ascorbic Acid and Phenolic Content Concentrations on Natural Reduction of Silver Ions from Plant Extracts. Int. J. Curr. Microbiol. App. Sci. 2016; 5(11):885-890
18. Srilatha B. Nanotechnology in agriculture. J. Nanomed. Nanotechnol. 2011, 2, 7, 5.
19. Wang X, Song H, Liu Q, Rong X, Peng J, Xie G *et al*. Effects of nanopreparation coated nitrogen fertilizer on nutrient absorption and yield of early rice, 2011.