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THE IMPACT OF IRON OXIDE NANOPARTICLES ON THE MORPHOLOGY, ALSO AND PHYSIOLOGY OF MUNG BEAN (VIGNA RADIATA)

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Abstract:

The purpose of this study was to investigate the impact of iron oxide nanoparticles on the morphology and physiology of Vigna radiata. The seeds of this plant were cultivated using varying concentrations of iron oxide nanoparticles, specifically at levels of 10, 50, 100, 500, and 1000 mg/l. The study unveiled that the presence of iron oxide nanoparticles had an impact on the growth of Vigna radiata at varying concentrations. The study observed an increase in root and shoot length with the increasing concentration of nanoparticles, ranging from 10 mg/l to 1000 mg/l. This suggests that the presence of iron nanoparticles had a stimulatory effect on plant growth. The levels of chlorophyll and carbohydrates exhibited an increase on the 15th day when compared to the 7th day. The content of soluble protein exhibited a strong correlation with the age of the plant, specifically indicating a decrease in soluble protein content as the plant's age increased. The soluble protein content was found to be higher on the 7th day as compared to the 15th day.

Key Words: Concentration, Yield, Nanoparticle, Carbohydrate, Bovine Serum Albumin.

Introduction:

Nanotechnology and nanomaterials have garnered significant interest due to their distinctive properties, such as a substantial surface area and heightened reactivity. These substances have been utilised as cosmetic additives, highly reactive catalysts, components of drug delivery systems, agents for cell imaging, and tools for cancer therapy. Additionally, they are utilised in the production of fertilisers and pesticides. Nanoparticles are utilised to enhance the nutrient availability to the shoots and roots of plants. Consequently, plants are exposed to and assimilate them. The plants are impacted in various ways by the uptake of these substances, which in turn influences their physiological processes. It has been observed that certain substances have the potential to exhibit toxicity towards plant cells and their organelles, while others may have a beneficial impact on plant growth (Monica and Cremonini, 2009). Various researchers have conducted studies to examine both the positive and negative effects. The observed effects were found to be dependent on the dose and duration of exposure, as well as the species involved. The need to clarify the potential harmful effects of nanotechnology in agriculture and other industries has arisen due to increased demands in this field. The objective of this study was to investigate the impact of iron oxide nanoparticles on Vigna radiata (Green Gramme), an essential plant species. The plants were cultivated using a hydroponic method in a Hoagland solution.

Figure 1: The plantlet of *Vigna radiata* hydroponically

Materials and Methods:

The chemicals used in the experiment include iron (III) chloride hexahydrate, iron (II) chloride tetrahydrate, ammonium hydroxide, trichloroacetate (TCA), thiobarbituric acid (TBA), sodium carbonate,

copper sulphate, sodium potassium tartarate, Folin-Coicalteau reagent, acetone, sodium phosphate buffer, and phenol, among others.

The laboratory equipment includes beakers, wire gauzes, air pumps, slides, brushes, forceps, blades, droppers, glass rods, spatulas, pipettes, micropipettes, cuvettes, test tubes, watch glasses, mortar and pestle, Whatman filter paper, Buchner funnels, centrifuges, spectrophotometers, weighing balances, magnetic stirrers, and pH metres. The Micro Image Projection system was utilised to capture images of plant sections. Iron oxide nanoparticles (Fe30, NPs) were synthesised following the procedure outlined by Maity and Aggarwal (2007). The specified quantities of $FeCl36H_2O$ (0.32 grammes) and $FeCl_24H_2O$ (0.16 grammes) were dissolved in 40 millilitres of deionized water. The solution was subjected to heating at a temperature of 80°C for a duration of 1 hour, with simultaneous stirring. Next, a rapid addition of 5.0 ml of ammonium hydroxide (30% w/v) is made to the solution. The suspension is thoroughly agitated for an additional hour and subsequently allowed to cool to ambient temperature. The precipitated particles were subjected to a series of washing steps using both hot and cold water. The particles were then separated using magnetic decantation and subsequently dried at a temperature of 70 °C for a duration of 1 hour. The utilisation of dry powder was employed for subsequent experimentation.

Experimental Design:

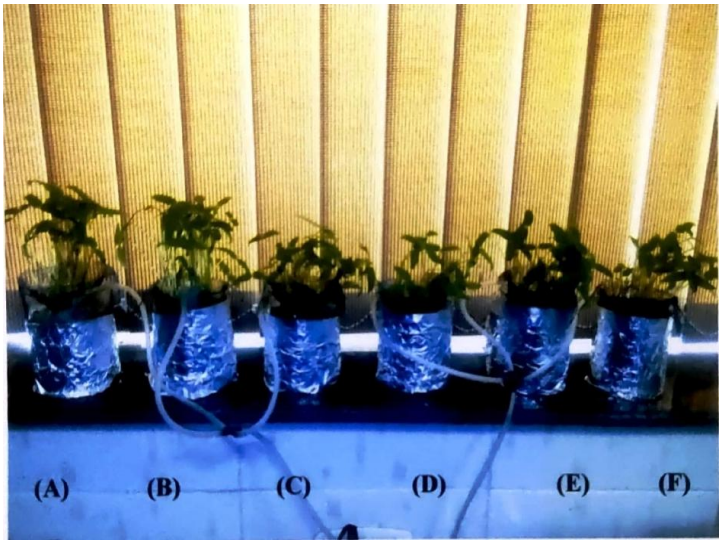

Figure 2: Experimental set up of *Vigna radiata* grown under different concentrations of iron oxide NPs, showing the actual conditions under which the plants were grown. Control is on left side (A) and the other concentrations are onward10 (B), 50 (C), 100(D), 500(E) and 1000(F) mg/l.

Total protein, total carbs, measurement of chlorophyll, and a totally randomised design were all used to evaluate the impact of various doses of Iron oxide NPS on Vigna radiata development, as shown in figure 2. Six sets of seeds were separated based on their treatment. The control group (group A) had seedlings cultivated without the presence of nanoparticles. The remaining groups (B, C, D, E, and F) were all reared while being exposed to iron oxide NPS at final concentrations of 10, 50, 100, 500, and 1000 mg/l, respectively. In order to eliminate any traces of the dangerous mercuric chloride, which was used to surface sterilise the mung bean seeds, they were rinsed three or four times with distilled water. Six hours were spent individually soaking seeds from each of the six groups in distilled water with varying amounts of iron nanoparticles. The treated seeds were put in petridishes that had filter paper inside that was wet. The seeds that showed the radical emerging from the seed coat after 24 hours were noted as having germinated. The impact of metal oxide nanoparticles on seed viability was assessed by looking at the percentage of seeds that germinated. The plants were then cultivated hydroponically in Hoagland's solution with the aforementioned iron NP concentrations. Air pumps were used to properly aerate the liquids containing suspended nanoparticles. Using a ruler, the root and shoot lengths were measured every two days for up to 15 days. On the seventh and fifteenth days of treatment, measurements of chlorophyll, total phenol, total protein, and total carbohydrate were made.

Results and Discussion:

Results of Root and Shoot Length Measurement:

The Hogland solution, which contains concentrations of 10, 50, 100, 500, and 1000 mg/l iron nanoparticles, was used to hydroponically grow the mung plants. Air pumps were used to properly aerate the liquids containing suspended nanoparticles. Up until the 14th day, the length of the roots and shoots were measured every other day with the use of a box and a ruler.When iron oxide nanoparticles were tested by Dhoke et al. (2013) for their impact on Vigna radiata seedlings, healthy growth was seen. Similar significant impacts were found by Souad A. Elfeky et al. (2013) in Ocimum basilicum L. growth characteristics (branches, leaves

number).According to Table 2, root and shoot length increased as nanoparticle concentration rose from 10 to 1000 mg/l. Therefore, we may conclude that iron likely had a stimulating impact on plant growth.

Table 2: Results were presented as mean ± S.D. for n = 10 of *Vigna radiata* from 2nd day - 14th day.

S.No	Day	Concentration mg/l	Mean ± S.D. of root (cm)	Mean ± S.D. of shoot (cm)
1	2nd	Control	4.02 ± 1.1516	3.19 ± 0.6806
		10	2.92 ± 0.5770	3.56 ± 0.9958
		50	2.7 ± 0.9201	4.36 ± 0.8592
		100	3.5 ± 0.8498	4.6 ± 0.6799
		500	4.41 ± 0.5621	4.68 ± 0.8715
		1000	5.17 ± 1.2202	5.8 ± 0.9238
2	4th	Control	6.13 ± 1.6166	6.11 ± 0.9871
		10	7.58 ± 2.3785	7.23 ± 1.4048
		50	9.31 ± 1.7272	8.47 ± 1.1431
		100	9.68 ± 1.7536	9.72 ± 1.5010
		500	10.47 ± 1.9408	10.61 ± 1.3691
		1000	11.97 ± 2.3763	12.38 ± 1.6619
3	6th	Control	7.61 ± 1.7854	8.68 ± 0.7955
		10	9.51 ± 1.8610	10.16 ± 1.5204
		50	9.77 ± 1.5868	11.92 ± 1.6758
		100	9.93 ± 1.5973	13.44 ± 0.9961
		500	10.61 ± 1.6029	13.11 ± 1.5088
		1000	10.14 ± 2.0571	14.84 ± 2.3458
4	8th	Control	8.1 ± 1.6519	10.44 ± 1.1645
		10	9.89 ± 1.7565	11.95 ± 1.4812
		50	10.51 ± 2.0058	13.18 ± 1.3456
		100	10.63 ± 1.2284	14.46 ± 1.2730
		500	11.24 ± 1.2860	15.87 ± 0.8832
		1000	11.4 ± 2.2993	17.41 ± 0.9315
5	10th	Control	8.78 ± 1.2541	11.7 ± 1.1547
		10	10.53 ± 1.7839	13.53 ± 0.7379
		50	11.21 ± 1.8181	14.6 ± 0.9463
		100	13.39 ± 1.0225	15.78 ± 0.7177
		500	14.3 ± 1.1528	17.15 ± 0.7517
		1000	15.39 ± 0.8774	19.46 ± 0.9675
6	12th	Control	10.51 ± 1.2991	12.43 ± 1.1166
		10	11.86 ± 1.4331	14.37 ± 0.8883
		50	12.98 ± 1.4680	15.25 ± 1.0814
		100	14.3 ± 0.9055	16.48 ± 1.0020
		500	15.26 ± 0.8540	17.32 ± 0.9004
		1000	16.32 ± 1.0152	20.19 ± 1.3650
7	14th	Control	12.06 ± 1.1918	13.57 ± 1.0371
		10	13.24 ± 0.9501	15.33 ± 0.9238
		50	14.33 ± 1.0457	16.05 ± 0.9652
		100	15.37 ± 1.0698	17.45 ± 0.9083
		500	16.36 ± 1.1520	18.37 ± 0.6767
		1000	17.19 ± 1.1160	21.81 ± 1.5536

Conclusion:

Protein diversity is crucial for both a plant's ability to respond to stress and its capacity to adapt to its surroundings. According to Hong-Xuan Ren et al. (2011), the level of soluble protein was closely associated with the age of the plant, meaning that it declines as age increases. According to research done by E. Nadi et al. (2013) on the impact of nano-iron chelate fertiliser on faba beans, raising the nano-iron concentration had a favourable and substantial impact on the protein content.When compared to the 15th day, the content of soluble protein was shown to be greater at day 7. However, the amount of soluble protein increased as the nanoparticle concentration rose from (10 mg/l to 1000 mg/l). Therefore, iron oxide nanoparticles may have a stimulating impact on plants' total protein content.

References:

1. Aslani F. Bagheri S., Julkapli N.M., Jurarimi A.S., Hashemi F.S.G., Baghdadi A. (2014), Effect of engineered nanomaterials on plant growth: An overview. The Scientific Word Journal, 1-28

2. Bhattacharyya A., Mohammad F., Naika H.R., Epid S. Timothy T., Reddy J., Parkasham R. S. (2015), Nanoparticles and their Impact on plants. Research Journal of NanoScience and Nano Technology 5 (2): 27-43
3. Blanco-Andujar C.Tung L. D., Thanh N.T.K (2010), Synthesis of nanoparticles for bio-medical application. Journal of Royal society of Chemistry, 553-668.
4. Burke D.J., Pietrasiak N., Situ S.F., Abenjar E.C., Porche M., Kraj P., Lakliang Y., Samia A.C.S. (2015), Iron oxide and titanium Dioxide nano-particles effect on plant performance and root associated microbes. International Journal of Molecular Science, 16, 23630 - 23650.
5. Dhoke KS, Mahajan P, Kamble R, Khanna A (2013), Effect of nanoparticles suspension on the growth of mung (Vigna radiata) seedlings by foliar spray method, Nanotechnology Development,3, 1, 1-5.
6. Elfesy S.A., Mohammed M.A., Khater M.S., Osman Y.A.H., ElsherbiniE. (2013), Effect of Magnetite nano-fertilizer on growth and yield of Ocimum basilicum L. International Journalof Indigenous Medicinal plant, 1286-1293.
7. Ghafariyan HM, Malakouti JM, Dadpour RM, Stroeves P, Mahmoudi M (2013), Effects of magnetite nanoparticles on soyabean chlorophyll, Environment Science Technology,47,10645-10652.
8. Giordani T, Fabrizi A, Guidi L, Natali L, Giunti G, RavasiF,Cavallini A, Pardossi A (2012), Response of tomato plants exposed to treatment with nanoparticles, Environmental quality, 8, 27-38.
9. Sheykhbalou R, Sedghi M, Mehdi TS, Rauf SS(2010), Effects of nano- iron oxide particles nagronomic traits of soyabean, Notulae Scientia Biologicae, 2, 112-113.
10. Singh A., Singh N.B., Hussain I., Singh S.C. (2015), Plant-Nanoparticles interaction: an approach to improve agricultural practices and plant productivity of. International Journal of Pharmaceutical Science Invention, 25-40.
11. Siva G.V., Benita L.F.J. (2016), Iron oxide Nanoparticle Promotes Agronomic Traits of Ginger (Zingiber officinale Rosc.). International Journal of Advanced Research in Biological Sciences, Vol. 3.
12. Valadkhan M, Mohammadi K/Nezhad TK (2015), Effect of priming and foliar application of nanoparticles on agronomic traits of chickpea. An International Journal of Biological forum 7(2),599-602.
13. Wang M., Liu X.P., Hu JLi J.L, Huang J. (2015), Nano- ferric oxide promote watermelon growth. Journal of Biomaterials and Nano biotechnology, 6, 160-167.
14. Wang H, Kou X, Pei Z, Xiao QJ, Shan X, Baoshan X(2011), Physiological effects of (Lolium perenne L.) and Pumpkin on perennial ryegrass magnetite nanoparticles (Curcurbita mixta) plants, Nanotechnology, 5, 1, 30-42.