Impact Factor-8.632 (SJIF)
ISSN-2278-9308

B.Aadhar

Single Blind Peer-Reviewed & Refereed Indexed
Multidisciplinary International Research Journal

June-2023
ISSUE No - (CDXVIII) 418 & Vol.- A

ENVIRONMENT : ISSUES & CHALLENGES

This Journal is indexed in :
- Scientific Journal Impact Factor (SJIF)
- Cosmos Impact Factor (CIF)
- International Impact Factor Services (IIFS)

For Details Visit To : www.aadharsocial.com
Aadhar Publications

Impact Factor – (SJIF) –8.632 ISSN – 2278-9308

B.Aadhar

Single Blind Peer-Reviewed & Refereed Indexed

Multidisciplinary International Research Journal

June- 2023

ISSUE No- (CDXIX)) 419 & Vol.- A

ENVIRONMENT : ISSUES & CHALLENGES

Chief Editor
Prof. Virag.S.Gawande
Director
Aadhar Social Research &, Development Training Institute, Amravati.

Executive-Editor
Prof. Dr. Priyaraj Maheshkar
Officiating Principal
Priyadarshini Mahila Mahavidyalaya, Wardha

Editor
Dr. Dhananjay Sonttakke
Professor & Head
Department of Sociology
Priyadarshini Mahila Mahavidyalaya, Wardha

Aadhar International Publication

For Details Visit To : www.aadharsocial.com

B.Aadhar' International Peer-Reviewed Indexed Research Journal
Impact Factor -(SJIF) -8.632, Issue No(CDXVIII)) 418 & Vol.- A
ISSN : 2278-9308
June 2023

INDEX-A

Phytotoxic Effect of Green synthesized Silver Nanoparticles (Ag Nps) on seed germination and seedling growth in Allium cepa

Jagtap S M[1] and Shelar J C[2]

1. Department of Botany, HutatmaRajguru Mahavidyalaya, Rajgurunar,Tal-Khed, Dist-Pune,MH,India
2. Department of Microbiology, SahebraojiButtepatil Mahavidyalaya, Rajgurunar,Tal-Khed, Dist-Pune,MH,India ,Corresponding Author- Email- shilu237@gmail.com

Mobile No 9890392368

ABSTRACT: -

Many scientists are working on NPs to find out their potential adverse effects on the environment and on human health. According to them NPs can cause a wide variety of toxicological effects on human, environment, bacteria and aquatic organisms. For synthesis of silver nanoparticles 10 mL of *Coccinia grandis* leaf extract was added to 90mL of 1mM aqueous AgNO□ solution in 250 mL flask. Then the flasks were incubated in dark at room temperature. The silver nanoparticle solution thus obtained was observed for colour change. A control setup was also maintained without leaf extract. Then purification of silver nanoparticle solution was done by repeated centrifugation at 10,000 rpm for 15 min followed by separation of the pellet in distilled water The structural and optical properties of NPs were find out by ultraviolet-visible spectrophotometer (UV-Vis), Fourier transform infrared (FTIR) spectroscopy and dynamic light scattering (DLS). UV peaks at 300–380 nm confirmed the presence of pure Ag NPs. DLS showed their size whereas FTIR further confirmed the presence of bio-active functional groups involved in the reduction of bulk zinc acetate to Ag NPs.In present investigation, different concentration AgNps were made and applied on onion seeds to study the effect on seed germination and early seedling growth. Seedgerminationdecreased in treated seed as compared to control.

Keywords-AgNPs, *Coccinia grandis*, Seed germination

INTRODUCTION

Nanotechnology is one of the most activeand vigorous areas of research in the field of modern material science. Due to the specific characteristics like size, distribution and morphology nanoparticles shows distinct properties compared to bulk form of material (Shriram et al., 2014). Nanoparticles are very attractive materials to handle in biological system because of microscopic size with at least one dimension less than 1000nm. Nanoparticles are found to be very effective in sensing and detection of biological structures and systems(Singhet al., 2008).Appearance of Metal nanoparticles in different shapes such as nano-powder or nano-cluster or nano-crystal and variation in sizes ranging from 2 nm to 1000 nm.

Chemically synthesized nanoparticles have adverse effect on environment so there is need to work on method for synthesis of nanoparticles which is eco-friendly. In recent studies, it is observed that nanoparticles can bebiologically synthesized by using plant which is not hazards to environment and human health.Green synthesis of nanoparticles has gained attention due to its trustworthy and eco-friendly nature (P.Mohanpuria et al., 2008). Biosynthesis offers better control over the growth of nanoparticles crystals due to the slow rate of synthesis, stabilization and steric hindrance (Poulose et al., 2013). Synthesis of nanoparticles using biological components has importance due to their unusual photo electrochemical chemical, opticaland electronic properties. The physical and chemical methods of silver nanoparticle synthesis were practised from many years, but they are very costlyand it require various toxic chemicals for their synthesis so biological synthesis is best option for synthesis of silver nanoparticles.

Because silver has been known to have antimicrobial and disinfecting effect,Silver nanoparticles have important applications. It has been studied that silver nanoparticles are nontoxic to mankind and shows activity againstviruses, bacteria, and other microorganisms without any side effects at low concentrations. same concentration silver is showing different result on human cells and micro-organisms, harmful to microorganism but not to human cell. (N. Savithtramma et al.,2011). Silver nanoparticles play a significant role in field of medicine and biology. AgNPs are extensively used for its novel properties in catalysis, chemical sensing, bio sensing, photonics, electronic and pharmaceuticals (Vijaya raj et al., 2012). Silver nanoparticles used in biomedicine especially for antibacterial and antiviral agents. Silver is nontoxic effective antimicrobial agent used for centuries. Silver shows a very high potential in wide range of biological applications. Most particularly it is used in form of nanoparticles.

Mehata*et al* 2016 stated that the interaction between nanomaterials and plants is still unknown. According to Kaegi et al.,2010 and Nowack 2010 research on the effect of silver nanoparticles (AgNPs) on plants is continued. Husen and Siddiqi 2014 reported that dissimilarities in terms of translocation, biotransformation, accumulation, absorption and toxicity of nanomaterials in plants. Cheng et al., 2010; Tripathi A. et al.,2017 observed the effect of AgNPs on plants shows variation as per change in NP size and its concentration, age and plants species, the method and duration of experimental exposure and various experimental conditions. Studies have shown that AgNPsrelease ionic silver into surrounding which generate reactive oxygen species (ROS) this cause oxidative stress and inhibition of respiratory enzymes. Cell damaged by oxidative stress produced by NPs andIt has been proven that this is very common mechanism of cell damage marked in many NPs toxicity studies (Yang etal.,2009).Particles may produce intracellular oxidative stress by disturbing the balance between oxidant and anti-oxidant processesupon entering the cell.

On the basis of various study, it is not clear that toxic effect of AgNPs is caused by its intrinsic property or by shedding ionic sliver.Present day literature showing limited research on the effect of AgNPs on plants and also their positive andnegative effecton environment is not clear so there is need to check their impact on Plant and Environment.

MATERIALS AND METHODS

3.1 MATERIALS

Silver Nitrate, Onion seeds, *Cocciniagranndis* leaves.

3.1.1 Plant samplesCollection

The fresh leaves of *Coccinia grandis* were collected from Rajgurunagar area, Pune, Maharashtra. To remove dust particles, the leaves were washed with distilled water thrice and then dried under direct sunlight for one to two weeks for complete removal of moisture (Velavan et al., 2012).

3.2 METHODS

3.2.1 Leaf extract Preparation

The dried leaves were crushed well with mortar and pestle to make a powder. Then 25 grams of powder sample was added into 100 mL of distilled water and the mixture was boiled for 30 min at 75°c. The leaf extract was cooled down and filtered with Whatman No. 1 filter paper. Then filtrate was collected and stored at 4°c for further use (Arunachalma et al., 2012).

3.2.2 Biosynthesis of silver nanoparticles using plant extract

For synthesis of silver nanoparticles 10 mL of *Coccinia grandis* leaf extract was added to 90mL of 1mM aqueous AgNO□ solution in 250 mL flask. Then the flasks were incubated in dark at room temperature. The silver nanoparticle solution thus obtained was observed for colour change. AgNO□ solution without leaf extract is control. Then By repeated centrifugation at 10,000 rpm for 15 min,silver nanoparticle solution was purified,followed by re-dispersion of the pellet in distilled water. The AgNPs were stored at 4^0c for further use.

3.2.3 Characterization of synthesized silver nanoparticles

Characterization of AgNPs is important for evaluation of functional properties of synthesized nanoparticles. It is also important for determination of size, Shape, distribution and morphology. Various analytical techniques like UV-Visible spectroscopy, Dynamic Light Scattering (DLS), FTIR, are used for characterization of silver nanoparticles. In present study, AgNPs synthesized from plant leaves extract of *Coccinia grandis* were characterized by the UV-Vis spectroscopy, FTIR and DLS.

3.2.3.1 UV-Visible spectroscopy

UV-Visible spectroscopy is very useful technique for the primary characterization of synthesized nanoparticles. Optical property of AgNPs was determined by UV-Vis spectroscopy. Colour change is observed due to the reduction of silver ions into silver nanoparticles during exposure to plant extract. The colour change is due to the surface Plasmon resonance phenomenon. The colour change was recorded with help of UV-Visible spectroscopy between 300 to 700 nm.

3.2.3.2 Fourier transform infrared spectroscopy

Identification of types of chemical bonds in a molecule by producing an infrared absorption spectrum that is like a molecular fingerprint is done by FTIR which is a powerful toolfor identification of suchtypes of chemical bonds in a molecule. FTIR was used for detection of functional group in synthesized AgNPs. The spectra were recorded on FTIR spectrophotometer at range of 3500-500cm[]¹.The chemical composition of synthesized nanoparticles was studied by using FTIR spectroscopy (T. Sriram et al., 2014).

3.2.3.3 Dynamic Light Scattering(DLS)

hydrodynamic diameter is measured by DLS. DLS is used to analyze the particle size of silver nanoparticle. Brookehaven instruments Ltd. was used to determine size of particle by determining dynamic fluctuations of light scattering intensity caused by Brownian motion of the particles.

3.2.3.4 Seed Germination Assay

In present investigation, effect NPsAgNPs on germination and seedling growth in onion was studied. To study of effect of NPs on seed germination and early seedling growth the graded concentrations (1mM,3mM and 5mM)of AgNPs was added aseptically to sterilized petriplates containing 50 surface sterilized onion seeds under laboratory condition(25±3°c).

On 10th day, seedlings were separated into shoots and roots. Seedling growth in terms of root length, shoot length, fresh weight and dry weight was recorded. Data obtained through germination studies and early seedling growth were used for calculation of parameters such as germination percentage, radicle length, plumule length and growth indices as given by Ashraf *et al.*(2006).Parameters like PHSI(Plant height stress tolerance index), RLSI(Root height stress tolerance index), DMSI(Dry matter stress tolerance index) were calculated. Experiments were carried out in triplicates(Raskar Shilpa V. and LawareS.L.(2014).

RESULTS

4.1 Biosynthesis of Silver nanoparticles

Biosynthesis of silver nanoparticles from silver nitrate and plant extract where Plant extract is used as a reducing agent (Velvan et al., 2012, Gulab et al., 2021). The synthesis of AgNP was confirmed by visual observation. The colour of the leaf extract and silver nitrate containing solution changed from dark green to dark brown after 24 hours of incubation. Thus, confirming the synthesis of AgNPs (M. Mala et al., 2017). colour arises in the solution due to surface plasmon vibrations.

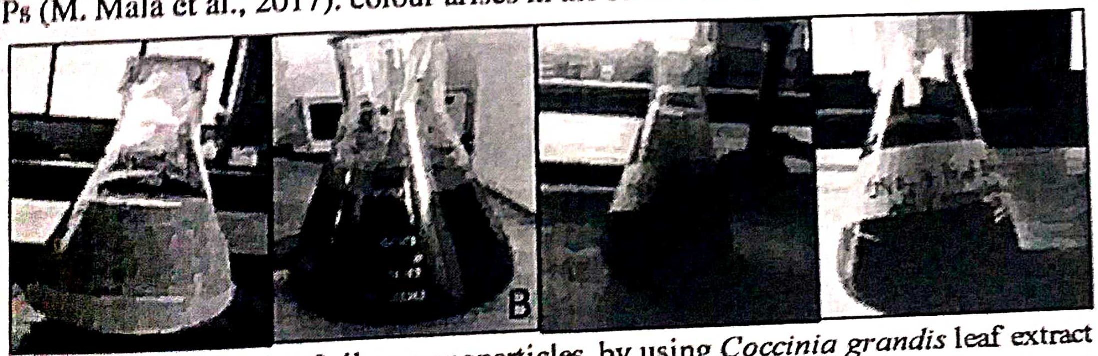

Fig: 4.1 Biosynthesis of silver nanoparticles by using *Coccinia grandis* leaf extract (A-AgNo3 Sol, B- Plant extract, C- Plant extract and AgNO3 before synthesis of NPs, D- Color change due to synthesis of Ag NPs)

4.2 Characterization of silver nanoparticles

4.2.1 UV-Visible Analysis

Primarily-the nanoparticles were characterized by UV–visible spectroscopy, which proved to be a very useful technique for the analysis of nanoparticles. The UV–vis spectra of reaction medium recorded as a function of reaction time using silver nitrate and *Coccinia grandis* leaf extract. It is observed that the maximum absorbance of Ag nanoparticles occurs in range of 300-700nm (fig4.2). This band corresponds to the absorption by colloidal silver nanoparticles in the region (300–380 nm) due to the excitation of surface plasmon vibration.

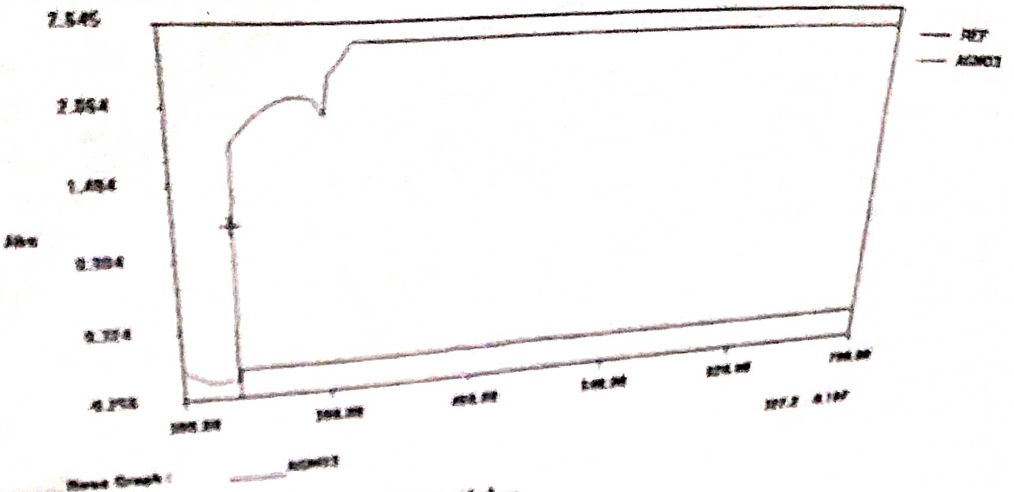

Fig: 4.2 UV-Visible spectra of Silver nanoparticles

4.2.2 Fourier Transform infrared spectroscopy analysis (FTIR)

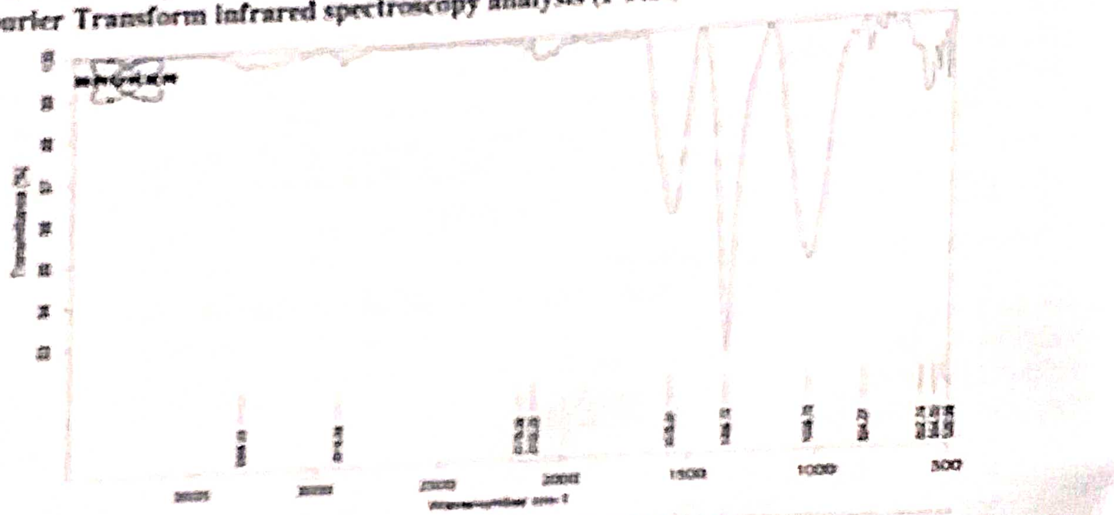

Fig4.3: FTIR spectrum of AgNPssynthesized by reduction of Ag+ ions by *C.grandis* leaf extract

FTIR spectrum of Ag nanoparticles examined to identify the possible biomolecules responsible for capping and efficient stabilization of the Ag nanoparticles synthesized by leaf extract. The peaks observed (Fig 4.3) for Ag nanoparticles formed through reduction by *Coccinia grandis* at 1356 cm−1 (Alcohol, Phenol) and 1576 cm−1 (amine) suggest the presence of flavonoids and phenols, C-N like amine, C-O like phenols adsorbed on the surface of Ag nanoparticles. The analysis of IR spectrum also provided an idea about biomolecules bearing different functionalities which are present in the underlying system. The results of FTIR analysis confirmed the presence of -NH-,-OH,C=C and CH groups.

B.Aadhar International Peer-Reviewed Indexed Research Journal
Impact Factor -(SJIF) -8.632, Issue No(CDXVIII)) 418 & Vol.- A
ISSN : 2278-9308
June 2023

4.2.3 Dynamic Light Scattering (DLS)

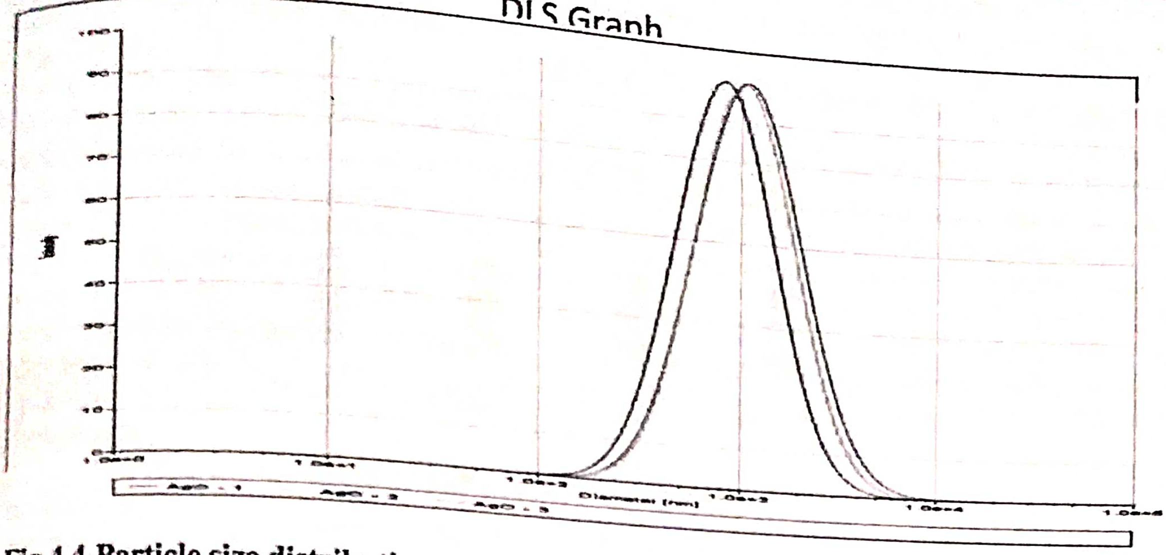

Fig 4.4-Particle size distribution of the biosynthesized AgNPs by DLS

DLS measures the size distribution and particle size characteristics by measuring random changes in light intensity scattered from a suspension or solution (Amini N *et al* 2017). The DLS size distribution image of biosynthesized silver nanoparticles is shown in Fig.4.4. This technique can be used to determine the average size of nanoparticles in liquidsThe average size of the synthesized AgNPs was 985 nm and 0.4 PdI value.

4.2.4 Seed Germination Assay

Effect of Ag NPs on seed germination and seedling growth of Onionseedlings–

Highest concentration (5mM) of AgNPs showed significantly low germination percentage i.e.,40 % whereas untreated seeds showed 76 % seed germination. In case of AgNPs, 1mM and 3mM concentrations show 76 and 70% seed germination respectively. Results pertaining to seed germination and early seedling growth clearly indicate that Ag NPs decrease seed germination and seedling growth linearly from 1mM to 5mM concentrations; higher concentrations (3mM and 5Mm) of Ag NPs showed decreased root length, shoot length and total seedling height (Fig 4.5)

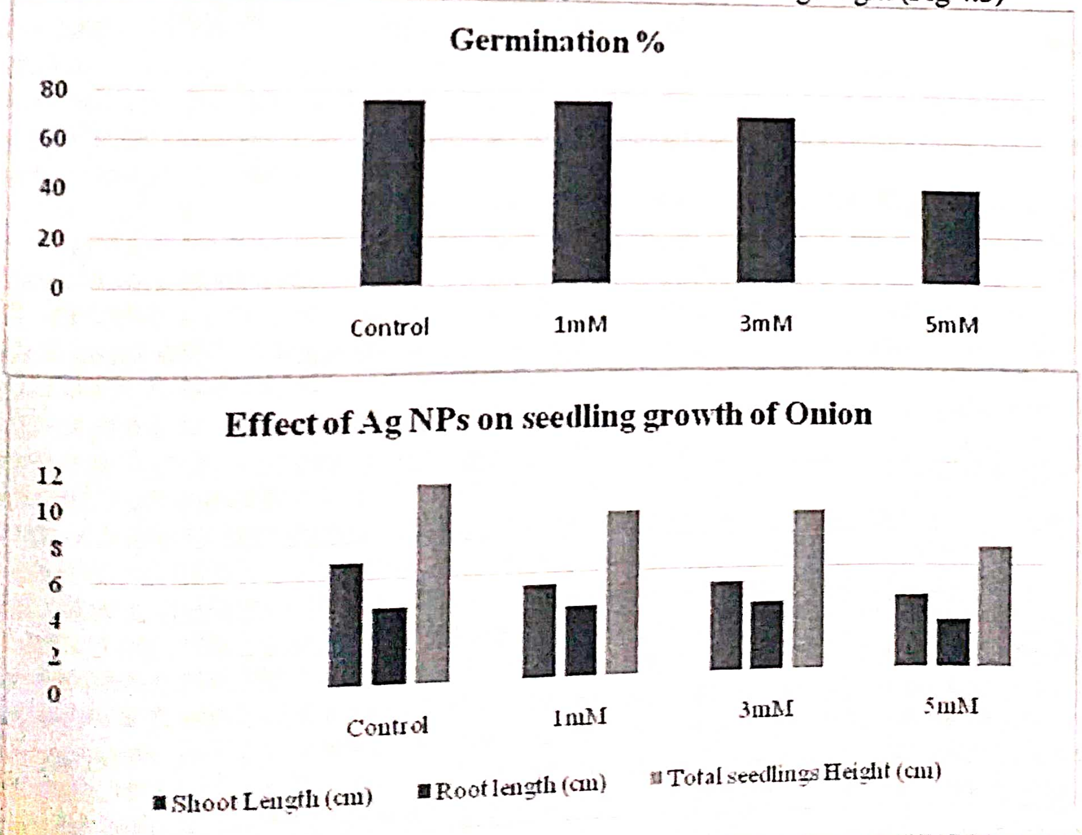

Fig-4.5Effect of Ag NPs on seed germination and seedling growth of Onion seedlings

Effect of Ag NPs onfresh weight and dry weight ofOnion seedlings

As concentration of AgNPs increases up to 5mM, fresh weight and dry weight of seedlings decreases from 270mg to 260mg and 43.2mg to 35mg (Fig-4.6)

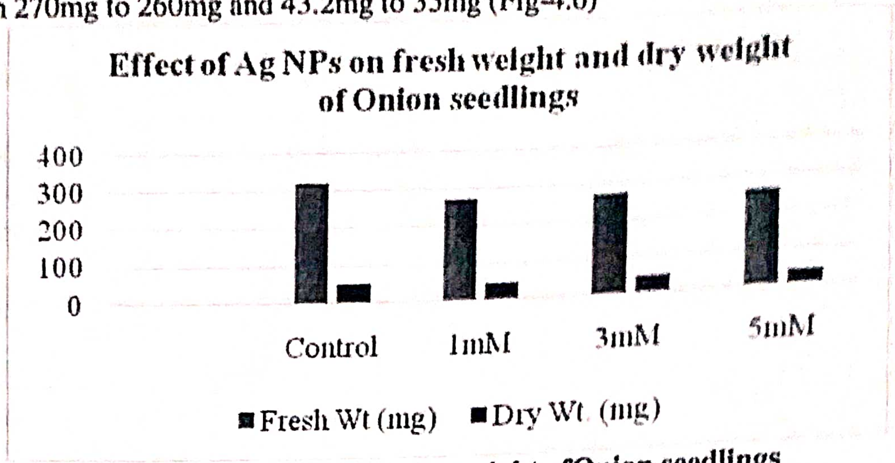

Fig- 4.6 Effect of Ag NPs onfresh weight and dry weight ofOnion seedlings

Effect of Ag on PHSI, RLSI, and DMSI of Onion

Plant height stress tolerance index (PHSI), Root length stress tolerance index (RLSI) andDry matter stress tolerance index (DMSI)showed the similar trendi.e., PHSI showeddecreases from 83.48 to 62.94, RLSI showed 93 to 65 and DMSI showed 84.3 to 68.3 in 1mM, 3mM and 5mM concentration of AgNPs(Fig-4.7).

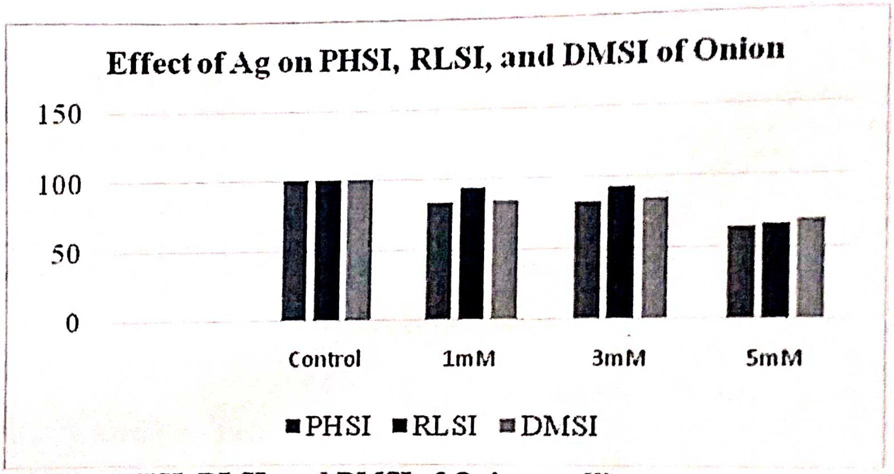

Fig-4.7Effect of Ag on PHSI, RLSI, and DMSI of Onion seedlings

Discussion-

Seed germination results indicate that AgNPs at their lower concentrations and higher concentrations showed slight adverse effects.Adverse effect of TiO_2 NPs in *Nicotina tabacum*observed by Ghosh *et al.*, 2010. They attributed such inhibition to DNA injury induced by TiO_2 NPs. This evidence supports that some engineered NPs could exert physical or chemical toxicity on plants, depending on their chemical composition, size, surface energy and plant species (Casals *et al.*, 2008). NPs' toxicity has been shown affected by Particle size, coating and surface charge (Choi and Hu, 2008; Elechiguerra*et al.*, 2005; El Badawy*et al.*, 2011).As the concentration of NPs increased there was decrease in seed germination, promptness index and seedling growth(Raskar S. and Laware S. L. 2013;S.V.Raskar and S.L.Laware 2014;Jagtap S. M. and Laware S. L. (2018)).

In present investigation seed germination is less affected than seedling growth. In a seed culture study, this was clearly demonstrated that seed germination was not affected by Ag NPs but both shoot and root growth was much more sensitive to Ag exposure than seed germination (Yin *et al.*, 2012). Lin *et al.* (2009) also reported that the seeds treated with five types of multi-walled NPs such as carbon nanotube, aluminum, alumina, zinc, and zinc oxide have no effects on the germination in *Raphanus sativus, Brassica napus, Lactuca sativa* and *Cucumis sativus*. However, they observed that the seed germination was inhibited by ZnO NPs in *Lolium multiflorum*.(Raskar Shilpa V. and

LawareS.L. (2014). Effect of copper nanoparticles on bean (*Phaseolus radiatus*)and wheat(*T.aestivum*) plants observeddecreaseingrowthparameters in the seedlings(Lee et al., 2008).Growth of watermelon and zucchini seedlings was positively influenced by AgNPshowever, AgNPs create toxicity on corn root elongation, (Almutairi and Alharbi,2015).Alteration in shoots and root growth of*Brassica* Species were also observed, small decrease in length of shoot and root of seedlings under AgNPs treatment was observed (Kanchan Vishwakarms et al.,2017) However, few other studies by Krizkova et al., 2008 have noticed that association of Ag^+ ions with roots distorted its epidermis structure and changed anatomical properties of sunflower plant. Blaser et al., 2008 further supported that it might be because of uptake of AgNPs through seeds and changes in membrane and other cell structures, as well as defensive mechanisms, and modification in cell division and/or cell elongation (Singh et al.,2014). Furthermore, Krizkova et al., 2008 in the same plant was observedarrested growth of various parts of plant along with damaged root hairs, while treatment with alumina and copper NPs have retarded the growth of seedlings (Yang and Watts,2005 and Lee et al.,2008).

Conclusion

Results show that Ag NPs at lower to higher concentrations decreased seed germination, and seedling growth in onion though these are green synthesizedAgNPs,Mild stress condition on the growth and metabolism of mustard seedlings imposed due tointeraction of biologically synthesized AgNPs. Silver shows a very high potential in wide range of biological applications. Most particularly it is used in form of nanoparticles.In the present investigation it is observed that even biologically synthesized Ag NPs are harmful to the plant so there should be control on free release of Ag NPs in Environment.

Reference

1. Sriram,T. andPandidurai, V.(2014). Synthesis of silver nanoparticles from leaf extract of Psidium guajava and its antibacterial activity against pathogens. International journal of current Microbiology and applied science.3,46-152.

2. Singh M; Singh S.; Prasad, S., Gambhi,r I. S. (2008). Nanotechnology in medicine and antibacterial effect of silver nanoparticles. Digest Journal of Nanomaterials and Biostructures; 33:115-122.

3. Ashraf M. Y., Akhtar K., Hussain F. and J. Iqbal (2006). Screening of different accessions of three potential grass species from Cholistan desert for salt tolerance. Pak. J. Bot., 38 :1589-1597.

4. P. Mohanpuria, N. K. Rana, and S. K. Yadav, (2008). J. Nanopart. Res. 10, 507.

5. PouloseSubin, Panda Tapobrata, Nair PraseethaP.Theodore, Thomas (2014). Biosynthesis of Silver Nanoparticles. Journal of Nanoscience and Nanotechnology; Vol. 14:2038–2049.

6. N. Savithramma, M. Linga Rao, K. Rukmini and P. Suvarnalatha devi (2011).Antimicrobial activity of Silver Nanoparticles synthesized by using Medicinal Plants.International Journal of ChemTech Research. 3,1394-1402.

7. D. Vijaya raj, j. Anarkali, k. Rajathi, s. Sridhar (2012). green synthesis and characterization of silver nanoparticles from the leaf extract of aristolochiabracteata and its antimicrobial efficacy. International Journal of Nanomaterials and Biostructures.2(2) 11-15.

8. Mehta, C. M., Srivastava, R., Arora, S., and Sharma, A. K. (2016). Impact assessment of silver nanoparticles on plant growth and soil bacterial diversity. 3 Biotech 6, 254. doi: 10.1007/s13205-016-0567-7

9. Kaegi, R., Sinnet, B., Zuleeg, S., Hagendorfer, H., Mueller, E., Vonbank, R., et al. (2010). Release of silver nanoparticles from outdoor facades. Environ. Pollut. 158, 2900–2905. doi: 10.1016/j.envpol.2010.06.009

10. Nowack, B. (2010). Nanosilver revisited downstream. Science 330, 1054–1055. doi: 10.1126/science.1198074

11. Husen, A., and Siddiqi, K. S. (2014). Phytosynthesis of nanoparticles: concept, controversy and application. Nanoscale Res. Lett. 9:229. doi: 10.1186/1556-276X-9-229

12. Cheng, L., Shao, M., Zhang, M., and Ma, D. D. (2010). An ultrasensitive method to detect dopamine from single mouse brain cell: surface-enhanced Raman scattering on Ag nanoparticles from beta-silver vanadate and copper. Sci. Adv. Mater. 2, 386–389. doi: 10.1039/b802405g

13. Tripathi, D. K., Singh, S., Singh, V. P., Prasad, S. M., Dubey, N. K., and Chauhan, D. K. (2017). Silicon nanoparticles more effectively alleviated UV-B stress than silicon in wheat (Triticum aestivum) seedlings. Plant Physiol. Biochem. 110, 70–81. doi: 10.1016/j.plaphy.2016.06.02
14. Velavansivanandam, Manonmanipurushothaman and Mahadevan karunanith (2012). Green synthesis of silver nanoparticles using plant leaf extract and evaluation of their antibacterial and in vitro antioxidant activity. Asian Pacific Journal of Tropical Biomedicine.1: 1-8.
15. Rajeswari Arunachalama, Sujatha Dhanasingha (2012). Photosynthesis of silver nanoparticles using Coccinia grandis leaf extract and its application in the photocatalytic degradation. Colloids and Surfaces B: Biointerfaces 94: 226–230.
16. M. Mala, A. Hannah Hepsibah, and G. Jeya Jothi. (2017). Silver Nanoparticles Synthesis Using Coccinia grandis (L.) Voigt and Momordica charantia L., Its Characterization and Biological Screening. Journal of Bionanoscience; Vol. 11:504–513.
17. Gulab S. Gugale, Bhushan P. Bhusare, Mukund S. Ambawade, Nitin S. Kadam and Akshay B. Shinde. (2021). Biosynthesis of Silver Nanoparticles using various botanicals and evaluation of its antimicrobial property. Jour Pl Sci Res;37 (2): 545-553.
18. Amini N, Amin G, Jafari Azar Z. Green synthesis of silver nanoparticles using Avena sativa L. extract. Nanomedicine Res J. 2017;2(1):57–63
19. Ghosh M, Bandyopadhyay M, Mukherjee A. (2010). Genotoxicity 343 of titanium dioxide TiO_2 nanoparticles at two trophic levels: plant and human lymphocytes. Chemosphere; 81: 1253-1262.
20. Casals E., Vazquez-Campos S., Bastús N.G. and Puntes V. (2008). Distribution and potential toxicityof engineered inorganic nanoparticles and carbon nanostructures in biological systems. Trends in Analytical Chemistry; 27 (8): 672-683.
21. Choi O, Hu Z.Q. (2008). Size dependent and reactive oxygen species related nanosilver toxicity to nitrifying bacteria. Environmental Science & Technology; 42: 4583–4588.
22. El Badawy A.M., Silva R.G, Morris B., Scheckel K.G., Suidan M.T., (2011). Surface Charge-Dependent Toxicity of Silver nanoparticles. Environmental Science & Technology; 45: 283–287.
23. Elechiguerra J.L., Burt J.L., Morones J.R., Camacho- Bragado A, Gao X, (2005). Interaction of silver nanoparticles with HIV-1. J Nanobiotechnology; 3: 6.
24. Raskar S. and Laware S. L. (2013). Effect of titanium dioxide nano particles on seed germination and germination indices in onion. Plant Sciences Feed. 3 (9): 103-107.
25. S.V.Raskar and S.L.Laware 2014) Effect of zinc oxide nanoparticles on cytology and seed germination in onion. Int.J.Curr.Microbiol.App.Sci(2014)3(2): 467-473
26. Yin L., Colman B.P., McGill B.M., Wright J.P., Bernhardt E.S. (2012). Effects of Silver Nanoparticle Exposure on Germination and Early Growth of Eleven Wetland Plants. PLoS ONE; 7(10): e47674. doi:10.1371/journal.pone.0047674
27. Lin C., Y. Fugetsu, F. Watari, (2009) Studies on toxicity of multi-walled carbon nanotubes on Arabidopsis T87 suspension cells, J. Hazard. Mater. 170:578–583.
28. Lei Z., Mingyu S., XiaoW., Chao L., Chunxiang Q., Liang, C., Hao H., Xiao-qing L, Fashui H. (2008). Antioxidant stress is promoted by nano-anatase in spinach chloroplasts under UV-B radiation. Biol Trace Elem Res; 121:69–79.
29. Almutairi, Z. M., and Alharbi, A. (2015). Effect of silver nanoparticles on seed germination of crop plants. J. Adv. Agric. 4, 283–288. doi: 10.1016/j.scitotenv.2013.02.059
30. Kanchan V. et al.,2017 Differential Phytotoxic Impact of Plant Mediated Silver Nanoparticles (AgNPs) and Silver Nitrate ($AgNO_3$) on Brassica sp. Front. Plant Sci. 8 - 2017 | https://doi.org/10.3389/fpls.2017.01501
31. Krizkova, S., Ryant, P., Krystofova, O., Adam, V., Galiova, M., and Beklova, M. (2008). Multi-instrumental analysis of tissues of sunflower plants treated with silver(I) ions—plants as bioindicators of environmental pollution. Sensors 8, 445–463. doi: 10.3390/s8010445
32. Blaser, S. A., Scheringer, M., Macleod, M., and Hungerbühler, K. (2008). Estimation of cumulative aquatic exposure and risk due to silver: contribution of nano-functionalized plastics and textiles. Sci. Total. Environ. 390, 396–409. doi: 10.1016/j.scitotenv.2007.10.010
33. Singh, V. P., Kumar, J., Singh, S., and Prasad, S. M. (2014). Dimethoate modifies enhanced UV-B effects on growth, photosynthesis and oxidative stress in mung bean (Vigna radiata L.) seedlings: implication of salicylic acid. Pestic. Biochem. Physiol. 116, 13–23. doi: 10.1016/j.pestbp.2014.09.007

34.Yang, L., and Watts, D. J. (2005). Particle surface characteristics may play an important role in phytotoxicity of alumina nanoparticles. Toxicol. Lett. 158, 122–132. doi: 10.1016/j.toxlet.2005.03.003

35. Jagtap S. M. and Laware S. L. (2018)Effect of Zno NPs on growth and productivityin OnionI J R B A T, Vol. VI (Special Issue 2), 63-66

36. Raskar Shilpa V. and Laware S.L.(2014). Influence of Zno and Tio2 nanoparticles on cytology and growth in onion *Allium cepa* L. http://hdl.handle.net/10603/199454