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Effect of Some Phytotoxic Substances on the Chlorophyll Content and Its Synthesis in Maize

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Abstract- *Plants are an important part of ecosystems because they provide the foundation for NP transport and a route for bioaccumulation in the food chain. One of the most important food crops in the world, maize supplies almost 30% of the food calories to more than 4.5 billion people in 94 developing nations, along with rice and wheat. A delay in seed germination, a suppression of plant growth, or any negative impact on plants brought on by particular compounds (phytotoxins) or growing conditions is referred to as phytotoxicity in plants. The phytotoxicity of aluminium, silver nanoparticles, and rare earth NP lanthanum oxide in maize crops, as well as several other crops like wheat and rice, is what we're talking about here.*
Keywords: *Plants, NPs, phytotoxicity, food calories, etc.*

I. Introduction

Any negative effects on plant development, physiology, or metabolism brought on by a chemical agent, such as high concentrations of fertilisers, herbicides, heavy metals, or nanoparticles, are referred to as phytotoxicity. Alterations in plant metabolism, growth inhibition, or plant mortality are examples of common phytotoxic consequences. Phytotoxins are chemicals that are harmful or dangerous to plant growth. Herbicides are an example of a human-made phytotoxic material, but other sources include plants, microbes, and spontaneous chemical reactions. Silver (Ag), arsenic (As), cadmium (Cd), cobalt (Co), chromium (Cr), iron (Fe), nickel (Ni), lead (Pb), and zinc are the heavy metals most significant to phytotoxicity in crops (Zn). Phytotoxicity, which is frequently brought on by the excessive use of fertilisers, can be produced by high concentrations of mineral salts in solution within the plant growing media. For instance, urea is utilised as a nitrogenous fertiliser in agriculture. However, if too much is used, urea toxicity or ammonia generation from urea hydrolysis may have phytotoxic effects. Because the intermediate products of this process are detrimental to plant growth, organic fertilisers like compost also have the potential to be phytotoxic if they are not properly humified.

Herbicides are created and applied to suppress undesirable plants, such as weeds in agriculture. However, the use of herbicides may have phytotoxic effects on plants that are not intended targets due to wind-borne spray drift or from the use of soil amendments containing herbicide contamination (such as straw or manure). Incorrect application, application at the inappropriate stage of crop growth, or excessive application of herbicides can all result in phytotoxicity in crops. An important area of research in the science of ecotoxicology is herbicides' phytotoxic effects.

Heavy metals are high-density metallic compounds that are hazardous to plants at low concentrations, while plant species, the particular metal and its chemical form, and soil characteristics all play a role in toxicity. Silver (Ag), arsenic (As), cadmium (Cd), cobalt (Co), chromium (Cr), iron (Fe), nickel (Ni), lead (Pb), and zinc are the heavy metals most significant to phytotoxicity in crops (Zn). These include the trace elements Co, Cu, Fe, Ni, and Zn, which are needed in very minute levels for enzyme and redox processes crucial to plant development. But once a certain point is reached, they turn toxic. The remaining heavy metals on the list are hazardous at any quantity, can bioaccumulate, and provide a risk to human health if ingested. Both natural and man-made sources can contaminate with heavy metals. Rock outcrops are the main natural source of heavy metals, while huge amounts of poisonous material can also be released during volcanic eruptions. Application of organic and inorganic fertilisers, as well as mining and smelting activities, are significant anthropogenic sources.

II. Data & Observation

Nanotechnology is a fast expanding field with a wide range of uses, including biology, electronics, and medication delivery. Smaller than 100 nm produced nanoparticles are consequently released into the environment. Depending on the type of plant and the concentration of the nanoparticles, plant uptake and bioaccumulation of these particles can have either beneficial or detrimental impacts on plant growth. As a result of the successful development of nanotechnology over the past few decades and its widespread use in industry, nanomaterials were inevitably released into the environment and ecosystem. Aluminum and silver nanoparticles (AgNPs) are two of the most widely employed nanomaterials in a variety of industries, including agriculture.

Understanding the effects of Al and AgNPs on plant growth and development is essential for the assessment of potential environmental risks imposed by Al and AgNPs on food safety and human health. Plants are the fundamental element of the ecosystem and the most significant source of food for humanity.

Engineered nanomaterials (ENMs) were created and enlarged for use in many industrial fields and everyday life due to their small size (between 1 and 100 nm) and distinctive chemical and physical features. Silver nanoparticles (AgNPs) are the most widely used nanomaterial among the numerous forms of ENMs. According to reports, AgNPs are used in around 25% of all consumer items utilising nanotechnology. They can be utilised in household goods, food packaging, textiles, medical devices, antiseptics in healthcare delivery, and personal healthcare because of their well-known antibacterial and antifungal qualities. Because of their excellent electrical conductivity and photochemical characteristics, AgNPs can also be used in electronic devices and wastewater treatment.

Phytotoxicity of Ag

AgNPs were created for use in agriculture as agents to speed up fruit ripening, fungicides to prevent fungal diseases, and stimulators of plant development. AgNPs are increasingly used, which necessarily raises the possibility of environmental discharge during AgNP production, absorption into goods, handling, recycling, or disposal of these items. AgNPs are anticipated to enter the ecosystem as surface waters (such as lakes, streams, and rivers), with biosolids from wastewater treatment serving as the primary channel. AgNP-contaminated water may seep into fields in agriculture through irrigation and fertiliser. The released AgNPs have the capacity to penetrate various mediums and eventually reach the rhizosphere of the plant. As a result, the AgNPs are inexorably absorbed by crops and readily infiltrate the food chain, having an adverse effect on food production and quality as well as posing a threat to human health. After mercury, silver is the metal that does aquatic species the most harm. Actually, silver ions (Ag^+), which are persistent, bioaccumulative, and extremely poisonous to organisms, can be released from AgNPs. As a result, there are serious questions concerning the safety and environmental toxicity of AgNPs that are released into ecosystems. Understanding how AgNPs affect plants is crucial for determining their toxicity since plants are an essential component of ecosystems and the primary trophic level in ecosystems, serving as the base of the food chain. As a result, the current analysis explains the uptake and translocation of AgNPs and provides a thorough summary of those affects on plants. For a better understanding of how plants and AgNPs interact, the phytotoxicity mechanisms—through which AgNPs have an influence on plants—as well as the tolerance mechanisms—through which plants counteract AgNPs' negative effects—are described.

AgNPs are delivered by vascular tissue and intercellular gaps in plants (short-distance transport) (long-distance transport). Following exposure to plants, NPs enter plant vascular tissues (xylem) and travel to the stele by penetrating cell walls and plasma membranes of epidermal layers in roots. The most significant means of distributing and transporting NPs is xylem. AgNPs can be absorbed by the xylem and transported to the leaves. AgNPs was absorbed and steadily accumulated in the root tips, beginning in the border cells and progressing to the root cap, epidermis, columella, and root meristem initials. According to a subsequent study, AgNPs in Arabidopsis adhered to the surface of primary roots and subsequently entered root tips shortly after exposure. AgNPs then gradually went deeper into the roots and reached lateral root primordia and root hairs. AgNPs were found in vascular tissue and all over the plant, from root to shoot, when many lateral roots formed. The primary site through which AgNPs enter plant cells is through the cell wall of the root cells. AgNPs must pierce the root epidermal layer's cell wall and plasma membranes in order to enter the plant. The cell wall functions as a natural sieve because it is a porous network of polysaccharide fibre matrices. Larger AgNPs are unable to penetrate plant cells and must be sieved out, whereas smaller AgNPs can pass through the pores.

It's interesting to note that AgNPs can promote the growth of new, sizable pores that allow massive AgNPs to pass through the cell wall. The plasmodesmata mechanism can also be used to transfer AgNPs inside the plant cell. Plasmodesmata, which connect neighbouring plant cells, have a diameter of 50–60 nm. AgNPs are found to aggregate in plasmodesmata and the cell wall of Arabidopsis, which raises the possibility that intercellular communication may be blocked. This blockage may be brought on by the mechanical presence of AgNPs at these locations, which may also have an impact on nutrient intercellular transport. AgNPs can be absorbed by plant leaves in addition to the root channel. Once the AgNPs have entered the vascular tissues of the crop, they can be absorbed and transported vast distances to the leaves or other organs. As a result, it's probable that translocation will cause AgNPs to contaminate edible plant components like fruits, seeds, and other edible plant parts.

Significant morphological alterations in plants were seen after exposure to AgNPs. For determining the phytotoxicity of AgNPs in plants, the most often employed criteria are growth potential, seed germination, biomass, and leaf surface area. It has been shown that exposure to AgNP can diminish biomass and leaf area, limit root growth, and inhibit seed germination. AgNPs dramatically reduced plant biomass, impeded shoot growth, and caused root abscission in Spirodela polyrrhiza, according to Jiang et al. Arabidopsis biomass decreased as a result of exposure to increasing concentrations of AgNPs, as demonstrated by Kaveh et al. AgNPs decreased the length of wheat shoots and roots in a dose-dependent manner, according to Dimkpa et al.

AgNPs' physiological phytotoxicity against plants is predicted by decreased chlorophyll and nutrient uptake, decreased transpiration rate, and altered hormone levels. AgNPs can interfere with the production of chlorophyll in leaves, which has an impact on the plant's photosynthetic system. AgNPs can build up in Arabidopsis leaves, further damage the structure of the thylakoid membrane, and reduce the amount of chlorophyll, which inhibits plant growth, according to research by Qian et al. According to Nair and Chung, rice seedlings' total chlorophyll and carotenoids concentrations drastically decreased after being exposed to AgNPs for a week. According to research by Vishwakarma et al., AgNPs can build up in mustard seedlings and severely impede photosynthesis. According to a recent study, exposure to AgNPs altered the Physcomitrella patens thylakoid, lowered the amount of chlorophyll b, and threw off the balance of several crucial elements. Significantly less total chlorophyll, total protein, and shoot and root elongation and fresh weights were present.

AgNPs can also alter the membrane's fluidity and permeability, which can therefore have an impact on how well nutrients and water are absorbed. According to research by Zuverza-Mena et al., radish sprouts exposed to AgNPs experienced a dose-dependent decrease in their water content as well as a significant reduction in their nutrient content (Ca, Mg, B, Cu, Mn, and Zn), indicating that AgNPs may have an impact on plant growth by altering these two factors.

Phytotoxicity of Aluminium

Al's phytotoxicity has been thoroughly investigated, and it generally causes plants to grow shorter and produce less fresh and dry weight. In comparison to complexed forms, soluble Al3 + or Al-hydroxy cations are more phytotoxic. Curiously, despite the fact that the majority of studies that are currently available on the phytotoxicity of Al use acidic solutions, little focus has been placed on the toxicity of H+ itself, despite the fact that it is well known that H+ is harmful to root growth, particularly in solutions with low ionic strength and low cation concentrations. Because of this, it's important to remember that Al toxicity in nature is just one aspect of a complex issue (including low pH toxicity and nutritional disorders). There is still much to learn about the interplay of these variables and the intricacy of their effects on crop output.

Al exposure causes damage that is primarily seen in the root tissues, which limits the plants' capacity to absorb nutrients. McBride discovered that the decline in root development in soils with acidic Al3 + activity. Since then, many different plant species have used this measure to evaluate the toxicity of aluminium.

Cell division and cell elongation are sacrificed in favour of root expansion. For Al-sensitive maize, it was proven in the 1990s that Al immediately inhibits root growth. Additionally, Al treatment was demonstrated to diminish root cell wall (CW) extensibility. The findings were interpreted as showing that cell elongation is the main mechanism preventing root development. Cell turgor pressure, which is responsible for cell elongation, is a complicated process that necessitates the release of CW components for its creation. Al may impede CW extension via binding to hemicellulose or pectins, which involves physical and/or physiological mechanisms, as well as a decline in enzymatic CW-loosening enzymes. Therefore, there is general agreement that Al's interaction with the apoplastic matrix affects CW extension and, eventually, root growth. Additionally, it supports the idea that Al quickly causes harmful consequences, which may manifest themselves while Al is still in the Donnan free space or on the apoplastic side of the plasma membrane.

Phytotoxicity of Lanthanum Oxide

In recent years, there has been a sharp growth in the use of lanthanum oxide nanoparticles (La2O3 NPs), which are unavoidably discharged into the environment. Applications for the rare earth oxide nanoparticles (NPs) include biomedicine, phosphate removal, semiconductors, agricultural films, electroforming electrode materials, catalytic promoters and/or supporters, high refractive optical fibres, and semiconductors. One of the most important manufactured nanoparticles is La2O3 NPs, a typical rare earth oxide nanoparticle. La2O3 NPs are inexorably released into the environment as a result of their extensive use, which is harmful to both plants and people. At 5 mg/L, La2O3 NPs caused phytotoxicity in maize. La2O3 NPs reduced the length, shoot biomass, and root biomass. La2O3 NPs also had a negative impact on the amount of chlorophyll. The net photosynthetic rate could be lowered by the decreasing chlorophyll content.

III. Conclusions

The current study outlines the uptake, transport, and accumulation of AgNPs in plants and illustrates how AgNPs can be hazardous to plants at various concentrations. It also focuses on the present state of knowledge on the processes through which AgNPs cause plant toxicity. Additionally, the processes of tolerance that underlie the survival tactics used by plants to deal with the negative effects of aluminium and lanthanum oxide, with a particular focus on AgNPs, are examined.

Both NPs with various surface coatings were tested at the gametophyte stages, and it was discovered that NPs without surface coating had the greatest negative impact on protonemata's chlorophyll, whereas AgNP-

PVP and AgNP-citrate barely showed any effect. This finding suggests that surface coating lessened NPs' negative effects on protonemata's chlorophyll. But during the stage of the leafy gametophyte, exposure to AgNP-citrate, followed by AgNP-PVP and AgNPs without a surface coating, caused the greatest weight loss in the leafy gametophytes. These findings imply that the impacts of diverse surface-coated NPs on plants are complex and related to both the stability of the NPs and various plant systems. The length, shoot biomass, and root biomass of maize plants were all reduced by NPs. Chlorophyll levels were negatively impacted by La2O3 NPs as well. The declining chlorophyll content may result in a reduction in the net photosynthetic rate.

References

[1]. Monica R.C., Cremonini R. Nanoparticles and higher plants. Caryologia. 2009;62:161–165. doi: 10.1080/00087114.2004.10589681. [CrossRef] [Google Scholar]

[2]. Sah S., Sorooshzadeh A., Rezazadeh H., Naghdibadi H. Effect of nano silver and silver nitrate on seed yield of borage. J. Med. Plants Res. 2011;5:706–710. [Google Scholar]

[3]. Sato S, Takahashi R, Kobune M, et al. Basic properties of rare earth oxides[J]. Applied Catalysis A: General, 2009, 356(1): 57-63.

[4]. Lin D, Xing B. Phytotoxicity of nanoparticles: inhibition of seed germination and root growth[J]. Environmental Pollution, 2007, 150(2): 243-250.

[5]. Balusamy B, Taştan B E, Ergen S F, et al. Toxicity of lanthanum oxide (La2O3) nanoparticles inaquatic environments[J]. Environmental Science: Processes & Impacts, 2015, 17(7): 1265- 1270.

[6]. Cui J, Hope G A. Raman and Fluorescence Spectroscopy of CeO2, Er2O3, Nd2O3, Tm2O3, Yb2O3, La2O3, and Tb4O7[J]. Journal of Spectroscopy, 2015, 2015.

[7]. Li R, Ji Z, Chang C H, et al. Surface interactions with compartmentalized cellular phosphates explain rare earth oxide nanoparticle hazard and provide opportunities for safer design[J].ACS nano, 2014, 8(2): 1771-1783.

[8]. Zhu H, Han J, Xiao J Q, et al. Uptake, translocation, and accumulation of manufactured iron oxide nanoparticles by pumpkin plants[J]. Journal of Environmental Monitoring, 2008, 10(6):713-717.

[9]. Zhang W, Ebbs S D, Musante C, et al. Uptake and accumulation of bulk and nanosized cerium oxide particles and ionic cerium by radish (Raphanus sativus L.)[J]. Journal of agricultural and food chemistry, 2015, 63(2): 382-390.

[10]. Shiferaw B, Prasanna B M, Hellin J, et al. Crops that feed the world 6. Past successes and future challenges to the role played by maize in global food security[J]. Food Security, 2011, 3(3): 307.

[11]. Ma Y, Kuang L, He X, et al. Effects of rare earth oxide nanoparticles on root elongation of plants[J]. Chemosphere, 2010, 78(3): 273-279.

[12]. Ma Y, Zhang P, Zhang Z, et al. Origin of the different phytotoxicity and biotransformation of cerium and lanthanum oxide nanoparticles in cucumber[J]. Nanotoxicology, 2015, 9(2): 262- 270.