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EFFECT OF NANOPARTICLES ON GROWTH AND GERMINATION OF PULSES

[1]Bindu, [2]Harsh, [3]Meenakshi, [4]Jakhar S.

[1,2,3,4] Department of Botany, Baba Mastnath University, Rohtak

KEYWORDS

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ABSTRACT

All nanoparticles' particles have their own properties and purposes. Nanoparticles like iron, silver, magnesium etc. they are commonly used nanoparticles in nanotechnology to improve the crop yield and germination. They affect plant in both ways in positive or negative ways. From the above result, it concluded that nanoparticles effect the growth, germination percentage, shoot length, Root length, and germination index of plant in a positive way. It has been seen that nanoparticles affect plant properties at a constant concentration. But when the concentration isn't suitable than the growth and germination of plant reduced or maybe they doesn't grow. Most commonly used nanoparticles are silver nanoparticles and it is a good growth stimulator for plants. It has seen in above result that silver nanoparticles are the most useful nanoparticles in agriculture. It increases the growth of plant at very high extent approx 85%. Some nanoparticles reduced the growth of plant and also they are toxic for crops yield and growth. They stop their enzymatic activities due to which they don't germinate. But if we treated seeds of a legume crop at a constant concentration, they achieve their extent growth and yield. Nanoparticles are also increases the growing speed of crop.

INTRODUCTION:

The term "Nanotechnology" was initial outlined in 1974 by Norio Taniguchi of the national capital Science University. Nanotechnology, abbreviated to "Nanotech", is that the study of manipulating matter on an atomic and molecular scale (Sainath Nagula and P.B. Usha., 2016).

Technology may be a promising field of knowledge base analysis. It unveils a large array of opportunities in varied fields like drugs, prescription drugs, physics, and agriculture. The doable uses and advantages of nanoparticles of technology square measure vast (Seyed saeid hojjat, Iran, Hamidreza hojjat. 2015). Technology has revolutionized the globe with nice accomplishment in several fields of science like engineering, biotechnology, analytical chemistry and agriculture. (Res. J. Nanosci., 2017)

Nanoparticles square measure atomic and molecular aggregates with a minimum of one dimension between one and a hundred nm which will severely modify their physio-chemical properties compared to bulk material. (Seyed saeid hojjat, Hamidreza hojjat. 2015). several countries square measure currently being switch over chemical based mostly agriculture to inexperienced agriculture, wherever the employment of biopesticides and conjointly biological nonphysical have a innumerable role to play in persecutor management (Bhattacharya et.al 2010; Stalder et.al 2010; Watson et.al 2011; Gogos et.al 2012; Sahayaraj, 2014a,b; De et.al, 2014)(Res... J. nanosci. 2017). they need attracted interest thanks to their distinctive properties (Gilroy et al., 2016; Liu and Di Valentin, 2019; Huang et al., 2020), together with quantum confinement, an oversized area to volume magnitude relation, high surface energy, different and several other} other chemical action and magnetic properties (Handy et al., 2008; Vallabani et al., 2019) (Souza-Torres.et.al., 2021) Nanoparticles has become a hotspot in analysis and development. Iron compound nanoparticles (IO-NPs) have attracted explicit attention thanks to their distinctive properties, that build them appropriate for a large vary of application in numerous fields like biomedicines, pharmaceutical, environmental correction etc (Ali et al; 2016).(florencia Iannone.et.al., 2021) it's been used as a semi-conductor, conductor, medical device, sensors, coating, and chemical action agents and conjointly as pesticides. The bulk of the rumored studies purpose to the positive impacts of nanoparticles on plant growth. So as to know the potential advantages of applying engineering to agriculture, opening move ought to be to investigate penetration and transport of nanoparticles in plants. Nanoparticles move with plants inflicting several morphological and physiological changes, counting on the properties of NPs. effectiveness of NPs is decided by their chemical composition, size, surface covering, reactivity, and most significantly the dose at that they're effective (Sainath Nagula and P.B. Usha., 2016). Besides, a range of metal nanoparticles silver (Ag), gold (Au), Al (Al), silica, metal and metal compound polymers oxide (ZnO) and oxide (TiO_2) square measure being developed for crop persecutor management. Like TiO_2 nanoparticles liable for chemical action and N metabolism. Another study by Mahajan studied the result of nano ZnO particle on the expansion of plant seed plant of golden gram (vigna radiate), gram (cicer arietinum).silver nanoparticles square measure presently one in every of the foremost used nanomaterial. Silver eliminates unwanted microorganisms in farmer soil and aquaculture system.

Silver ions such as AgNPs have recognized to inhibit ethylene action. It is being used as a foliar spray to prevent fungi, rot moulds, several other plant diseases (Seyed saeid hojjat, Iran, Hamidreza hojjat. 2015) .It was reported that plants and NPs features play an important role in NPs translocation. These are found in shoots but didn't accumulates in shoots such as in Oryza sativa shoots they are stored in it but didn't accumulates in shoots of Raphanus sativa and Cucurbit mixta. Some NPs were found to be translocated to aerial parts and accumulate in cellular pr sub-cellular compartments (AL-Amri et al, 2020). There are reports on NPs phytotoxicity that describe oxidative stress in plants exposed to NPs causing lipid preoxidation, as well as protein and DNA damage (florencia Iannone.et.al., 2021).

But with some positive effects, Nanoparticles even have some negative result on nature. Development of latest nonmaterial's and their application in varied industrial uses ends up in bigger pollution of the setting by nanoparticles. (Corredor et al. 2009). In recent years, the employment of nanoparticles increasing in industrial application. In 2005, the full international investment in technology was $10 billion and is about to achieve $1 trillion by 2015 (Harrison 2007), resulting in any increase of designed NPs free into our surroundings. Factory-made NPs enter the setting accidentally through region emissions, domestic waste water, agriculture, and accidental unleash throughout manufacture and transport (Klaine et al. 2008). This ultimately ends up in NPs entry into soil and water bodies thereby touching plants and animals. Because of their physical and chemical properties, NPs additionally move with living systems. Metallo–NPs dissent from bulk counterparts in surface characteristics, like copious reactive sites and quality regulated by deposition or aggregation (Maynard et al. 2006) that is successively passionate about pH scale, temperature, particle size, ionic strength, and concentration (Wiesneret al. 2006). These characteristics cause electricity, atomic number 1 bonding, and hydrophobic interactions with structural and chemical action proteins within the cell (M.V.J. DA COSTA and P.K. SHARMA., 2016). Comparative study concerning nanoparticles and metallo-NPs state that nanoparticles exist as colloids at low concentration and kind tiny stable aggregates at moderate concentration, whereas a little tiny low quantity of metallo-NPs dissociate into small ions (Navarro et al. 2008).

Nanoparticles of carbon, iron oxides, copper, zinc, manganese, cesium, and precious metals—gold and silver—are presently the most effective illustrious. The impact of nonmaterial's depends on several factors, like the genotype of take a look at organism, the tactic of application, the concentration and size of the nanoparticles, their chemistry properties, the degree of dispersion within the phase, or the kind of coating substance. In these nanoparticles handiest nanoparticles are silver NPs helpful effects of silver immaterial have conjointly been according within the case of growth of Indian mustard, switch grass, scoke, common bean and corn [11–13]. Seed germination was absolutely tormented by treatment with AgNPs in genus Boswellia ovalifoliolata plants and in bulrush millet. There also are several examples within the literature indicating the adverse effects of immaterial, together with AgNPs, on plants and helpful soil microbes. Genotoxic effects and harmful changes at the organic chemistry and physiological level are ascertained in plants within the presence of AgNPs [20–23]. These findings raise doubts on the security of their use in agriculture. (Pra zak.et.al. 2021) Nanoparticles have established to be ancient agrochemical agents so as to enhance the crop productivity, reducing the pests, increasing the nutrient uptake, inhibiting the pathogens and act as 'magic bullets' serving as herbicides, pesticides and fertilizers etc. (Deochand, Shanware, M. Barapatre.,2021) technology is very utilized in agriculture to enhance seed growth and germination by exploitation nanoparticles. The principal application of nanomaterial in crop production is that the reduction of the employment of agrochemicals and increase of the yield through tormentor and nutrients management. Recent studies have highlighted the potential applications of technology in crop production by up yield, organic process and nutraceutical worth.

Review of literature: -

Nanotechnology, an advanced technology which raises the hope in agriculture field to improve the crop quality, crop germination rate and all other difficulties that encountered in agriculture. Agriculture is backbone of most developing countries; with more than 60% of population depend on agriculture for their livelihood. Nanotechnology can get better our understanding of the biology of different crops potentially enhancing yields or nutritional values by developing better systems for monitoring environmental conditions and delivering nutrients or pesticides as appropriate (Dr.Priya, S Mukherjee, M Srinivasarao., 2020). Nanoparticles are atomic or molecular aggregate with at least one dimension between1 to 100nm. For the last few years, many experiments were performed in order to define the effect of nanoparticles on crop. Therefore, it is known that the nanoparticles have positive impact on seed germination, seed growth, and improvement of root and shoot formation and their ratio. Nanoparticles have positive and negative effect on crop plants. Like titanium oxide increases the photosynthesis and nitrogen metabolism and thus greatly improved the growth of spinach. Nanoparticles affect crops in many forms of materials like titanium oxide, zinc oxide, silver NPs etc.

In the paper on ecotoxicological effect of *Lecanicillium lecani* (Ascomycota: hypo cereals) based on silver nanoparticles growth parameters of economically important plants written by S.Karthick Raja Namasivayam and K.Chitrakala in 2011. This paper conclude about the ecotoxicologic effect of silver nanoparticles by using five different seeds- horse gram, sorghum, green gram, black gram and cowpea . Two different measurement were performed in this test –root elongation and germination percentage. After 25 days of germination, cowpea, green gram, and horse gram and black gram, sorghum their shoot length were slightly extended and reduced respectively in Ag nanoparticles treatment. In both control and Ag nanoparticles treatment horse gram, sorghum, green gram, black gram, and cowpea germinated within 3,5,2,4 and 2 days respectively. A slightly positive effect of Ag nanoparticles was observed which can be due to favorable biological response to low exposure of toxins and other stresses. While the germination index was similar of NP's their presence induced growth of longer roots.

When the same seeds treated with *L.lecanii* based nanoparticles, the leaf area of tested crop were reduced. They showed more impact in sorghum and horse gram than the other plants.Ag nanoparticles treatment extensively reduced the chlorophyll-B content in horse gram, sorghum and cowpea. But in green gram, it showed opposite impact in a way that the total chlorophyll content was reduced but the chlorophyll-A content increased by Ag nanoparticles.

S. Karthick Raja Namasivayam and K.Chitrkala (2011), states that the effect of silver nanoparticles and Lecanicilium lecanii based nanoparticles on 5 different seeds of different species of pulses. He concluded that under the effect of silver nanoparticles, sorghum shoots slightly lengthened and reduced respectively in comparison of other seeds of plants. And under the effect of L.lecanni based nanoparticles the leaf area of crops were reduced. The effect mostly seen in sorghum and horse gram plants.

Silver nanoparticles is the currently one the widely use nanomaterial. Silver ions such as Ag NPs have been recognized to inhibit ethylene action. Silver eliminates unnecessary microorganisms in farmer soil and hydroponic systems. It is used as a foliar spray to prevent fungi, rot, moulds and several other plant diseases. Beside it, silver is a great plant-growth stimulator, including silver salt, silicate and water soluble polymer to radioactive rays. Silver nanomaterial is the frequently used nanoparticles in this field after than nanotube. Seeded germination is a significant phenomenon in modern agriculture because it is thread of life of plants that guarantee its survival.

Fenugreek (*Trigonella foenum-graecum*) is a yearly plant in family of fabaceae, with leaves consisting of three small obovate to oblong leaflets. It is grown all over the world as a semi arid crop and its seeds are a common element in Indian subcontinent dishes. Its common name in Hindi is methi. Major fenugreek rising countries are Afghanistan, Pakistan, India, Iran, Nepal, Bangladesh, Egypt, France, Spain, Turkey etc. In India major producing states are Rajasthan, Gujarat, Uttarakhand, Haryana, Madhya Pradesh, Punjab etc. In all these states, Rajasthan account for 80% of India's output. Fenugreek was also used in health conditions, including menopausal symptoms and digestive problems. It was also used for inducing childbirth. But now a day's fenugreek is used to cure diabetes, loss of appetite and to stimulate milk production in breastfeeding women. It is also used to decrease skin redness.

Cicer arietinum is also known as chickpea. It is mostly cultivated in Mediterranean basin, Australia and Asia. cicer arietinum species belong to fabaceae family. Chickpea is a multipurpose grain legume widely used around the world, notably as a source of protein. Chickpeas are mainly cultivated in the cool, dry season of the semi-arid tropics on residual moisture. The article of influence of bioengineered zinc nanoparticles and zinc metals on cicer arietinum seedling growth by K. V. Pavan, V. Divya, I. Veena, M. Aditya, G. V. S Devakinandan (2014) state that metal nanoparticles are emerging alternate carrires to transmit and maintain the desired plant food resources available for plant growth and development. The effect of metal nanoparticles on plant is necessary to estimate them on seed germination and seedling growth. The main objective of this research is to point out the effect of zinc nanoparticles and zinc metals on growth and seedling germination of *cicer arietinum* at low concentration of nanoparticles. (Arora et al. 2012).

Root length Root length was improved in seeds exposed to Zn NPS. The root length is considerably affected in the seeds exposed to Zn metal (Fig.6). This may be due to the roots are the first target tissue to the toxic pollutants (Shaukat et al. 1999). The inhibition of root growth can be credited to the inhibition of mitosis, condensed cell wall synthesis and changes in metabolism (Smiri et al. 2013).

Shoot lengths in the presence of Zn NPs were notably larger than in control. The same results were found when seeds of Triticum aestivum were grown in the presence of 50 mg/L alumina nanoparticles (Pavani.et.al. 2014)

In the article of screening of phosphorus nanoparticles concentration based on their effect of germination and seedling level of Mung, Urd or Cowpea by Bhanu Priya, M. Srinivasarao1 and Subhra Mukherjee ,2015 conclude about the effect of phosphorus nanoparticles on germination and seedling growth of Mung, Urd or Cowpea. The six treatments using different concentration of P nanoparticles (10, 20, 30, 40, 50ppm) including control with sterilized water were used in this study. All the five concentrations of nano phosphorus exert positive impact on germination and seedling growth in all the three crops over control. It was observed that with increase in P NPs concentration, germination and growth of seedlings also increases.

Phosphorus is one of the essential elements required for growth of plant, animals and microorganism. Phosphorus is the main ingredient of all cell elements and plays a very important role in various processes (vance, 2011). Some soluble phosphate salts greatly used in agriculture as highly valuable phosphorus fertilizers. Due to this reason it effects surface water eutrophication. At the same time, solid phosphate is not as much effective in supplying phosphorus nutrient. Thus in the current situation of effect of phosphorus nanoparticles was considered on germination and seedling growth in 3 vigna species- Mung beans(*vigna radiate),* Urd beans*(vigna mungo*), cowpea(*vigna unguiculata)*. Seeds of these three species were selected and sterilized with 0...1% mercuric chloride solution for one minute and then sterilized them with distilled water. After that, six treatments were done by using five different concentrations (10, 20, 30, 40, and 50) of phosphorus nanoparticles including control with sterilized water. Ten seeds of each concentration of phosphorus nanoparticles treated for 48 hrs. For further studies, treated seeds were placed on glassplates at room temperature. During investigation these important characters were included- *germination %, root length, shoot length, root fresh weight, shoot fresh weight, leaf fresh weight, total fresh weight, shoot dry weight, root dry weight, leaf dry weight, total dry weight.*

Effect of phosphorus nanoparticles on germination and seedling growth in all three crops mung, urd, and cowpea seems positive. Highest germination % was recorded at 10 and 40ppm (96.67%) than 20 and 30ppm over control in mung. Beside it, in urd maximum germination was recorded at 20ppm(96.67%) followed by 40ppm and 30ppm and in cowpea germination rate was extent up to (96.67%) at 10, 30 and40ppm. Most favorable effect on root length and shoot length were found at 40ppm (20.630 and 20.660) in mung, 30ppm (19.600 and 20.663) in cowpea. At the same time Urd showed positive effect on root length at20ppm and 40ppm was found to be best for shoot length. A notable improvement was also recorded in shoot length (17.02%) and root length (49.6%) of mung bean with conformity of *Raliya et.al, (2015).* But after a definite trend of concentration, the shoot and root growth were seemed to decline in all the three crops. Maximum fresh weight of root, shoot, and leaf were recorded to range of 0.075%, 0.120 and 0.073 at 40ppm in mung. Alternate effect on root, shoot were leading at 40ppm, and in leaf fresh weight observed at 30ppm. In root, shoot, leaf was found maximum at 40, 20, 30ppm respectively in Urd. However effect on dry weight of root were found at 10, 20 and 40ppm, shoot dry weight was most at 40ppm (0.012) in mung, in urd 40ppm (0.014) along with 30ppm (0.011) were revealed superior for root dry weight, shoot dry weight was seemed effected at 20ppm (0.012). Since then started decline in weight and leaf dry weight was estimated better at 30ppm (0.025). Finest concentration for leaf dry weight observed at 40ppm and shoot dry weight of seedling also at 40ppm. While root dry weight was seemed to be maximum at 30ppm (0.06) beside 40ppm (0.057).

In mung, total fresh weight and dry weight was observed highest at 40ppm (0.268 and 0.027). In cowpea, total fresh weight and dry weight was best observed at 40ppm as in mung. Along with it perfect concentration for total fresh weight seemed at 40ppm (0.278) and 40 for total dry weight in urd. At the time of absolute concentration, *Mahajan et.al, (2011)* observed that the seedling shown good growth over control and after that *Liu et.al, (2014)* observed the significant of nano phosphorus initiate the growth rate and seed yield by 32.6% and 20.4% respectively. At 40ppm and 20ppm showed effective results on germination and seedling growth in mung (Bhanu Priya, M. Srinivasarao1 and Subhra Mukherjee., 2015) In the literature of studies on effect of polymers seed coating nanoparticles and hydro priming on seedling characters of pigeon pea (*cajanus cajan L.)* seed, shows the effect of zinc and iron nanoparticles on growth and germination of pigeon pea (*cajanus cajan L.).*

Cajanus cajan is a legume species of family Fabaceae. It is cultivated in India last 3,500 years ago. Ana its seeds are used as a common food grain in Asia, Africa, and Latin America. It is involved in large quantity generally in South Asia and consumed as an important source of protein for the population of that continent. Certainly it is originated in Peninsular India, where the nearby wild relatives (*cajanus cajan)* arise in tropical deciduous woodland. Pulses are essential ingredient in vegetarian diet. And main source of protein that nutritionally maintain the protein requirement of vegetarian population. They provide minerals and vitamins and maintain plenty of food energy. Pulses are also called *poor man's meal* because it is a cheaper ingredient of nutrients, proteins. Hence they mainly contain protein as twice as cereals. Pulses are also helpful for sustainable agriculture upgrading soil through biological nitrogen fixation about40-50 kg of n/ha. Pigeon pea is ancient growing crop of this century. Probably, it is second most nutrient rich crop only after chickpea. And India is the largest pulses showing country in world. Zinc and iron is the important micronutrient for the plant growth and development and also the needful element that are responsible for driving many metabolic reactions in all crops. These elements are used in for of nanoparticles in minute quantity for increasing seed quality in few crops. In this context, work was done in present experiment to find out the effect of seed polymerization with Zn and Fe nanoparticles on seedling character of pigeon pea.

Seed coating with Zn and Fe nanoparticles effect germination percentage of seeds. The highest germination percentage was found at 25ppm (94.75%) due to Fe NPs with seed polymer coating and was on par with Fe NPs at 10ppm (90.25%). In Zn NPs the highest germination percentage was found at 25ppm (91.25%). The main cause for increased germination was that the small size particles permit them to enter through seed coat easily. Therefore, support better absorption and utilization of these particles by seeds. These nanoparticles also effect the speed of germination was maximum in Fe NP at 25ppm (94.75) and in Zn NPs at 25ppm (91.75).

When compared with control (85.80). According to data the speed of germination was best in Fe NPs polymer at 25ppm among all treatment. The motive for rapid germination could be that the NPs may form new pore on seed coat during penetration which help to influx of water inside seed and NPs enters into seed through cracks which were present on surface of seed. Hence increase the speed of germination.In matter of seedling root length, the highest root length observed in Ta treatment (12.58cm) (polymer +Fe NPs at 25ppm) followed by T5 treatment (17.30cm) (polymer+ Zn NPs at 25ppm) compared with control (8.90cm). Among these treatment Fe NPs at 25ppm found to be best.

In seedling shoot length, the highest shoot length in Fe NPs (19.58cm) followed by Zn NPs at 25ppm (18.48) when compared with control (15.45cm). Prasad et.al. (2012) found that ZnO NPs induced the germination, root growth, and shoot growth.In matter of seedling length was higher in Fe NPs at 25ppm, followed by Zn NPs at 25ppm (29.78cm) and when compared with control (24.35cm).In early germination phase, activity and synthesis of hydrolytic enzyme increases due to which seed resulted in early emergence and growth of seedling .Due to increase in level of IAA in root resulted in increment in growth rate of seedling (B Bala Raju and Prashant Kumar Rai., 2017; ; 6(4): 140-145).

In the article of ‘engineered silica nanoparticles alleviate the detrimental effect of Na^+ stress on germination and growth of common bean (***Phaselous Vulgaris)*** by H.Alsaudi….(2017) shows the negative effect of Na^+ on phaselous vulgaris and by treating these seed with silica NPs reduce the effect of Na^+. With leguminous plants, common bean (Phaselous vulgaris) is determined the most significantly cultivated legume in world (Romero et.al.2013). it was cultivated in central and South America since from 6000 B.C. Probably 30 and 50% production of common bean was achieved by Europe and Asia respectively. But for the first time it was cultivated in Brazil. Therefore, common bean is perceptive for salinity. So the common bean yield found to be decreased in salt affected soil. In result, only 20-30% of production of common bean observed in middle east.In agriculture salinity is the most common reason for maximizing and sustainability of agricultural production. The major affect of salinity on plant growth is decreasing soil water potential and non-toxicity. So to avoid the impact of salinity, plant must have to increase their osmotic pressure in root tissues. Plant needs Na^+ in low concentration but when its concentration increase in plant then it become toxic and decrease plant growth, productivity and also blocking photosynthesis II by destroying chlorophyll or detrimental impact on physiological process.

After oxygen, silicon arrives in earth crust constituent by 28.8% based on dry weight. Si is universal and found in all living organism including plant and humans (Farooq and Dietz, 2015). Organic role of Si was firstly found for unicellular and multicellular organism. After this many higher plant such as cereals uptake Si in large amount than other important nutrients (Epstein, 2009). But in further studies, it was found that Si reduce stressful feature of biotic and abiotic (salinity, drought etc.) stress by disturbing physical and chemical defense system of plant (Epistein 2009; Ma et.al, 2011; Farooq and Dietz, 2015). By giving accurate dose of Si to plant to expected the induction in productivity and better quality. Major benefit from the rise the of Si is to increase water using efficiency in plant by decreasing evatraspiration through stomata and also make disease resistant by increasing stimulation of some antioxidant enzymes. The main objective of NS to improve the seed germination and growth of common bean under Na^+ stress.

Consequences of final germination percentage of common bean seeds growing under higher Na^+ concentration with and without NS are observed. Higher concentration of Na^+ stress extremely affected the final germination percentage of common bean. In result, it was found that FGP decline to 57.7% at 5000mg Na^+ than to 82.3% for control (zero Na^+) when no NS was applied. But under NS, FGP significantly inc decreased than untreated seeds of all Na^+ concentration.NS didn't affect MGT (mean germination time) of common bean seeds. It was found that under NS doses MGT decreases at low Na^+ concentration upto 2000mg L^{-1}. Shortest (5.240 days) MGT was found at 300mg L^{-1} when there was no Na^+ present in germination medium along all treatment. MGT decreased to 5.83 days when 300mg L^{-1} of NS was included at same Na^+ level. So, it showed large effect on MGT of common bean seeds under0, 100 and 200mg L^{-1} NS, recording 5.4, 5.32, 5.50 days respectively contrast to 5.90 days when no Na^+ and NS were used.

Germination speed (G) of seeds decreased probably 32.4%at a level of 5000mgNa^+L^{-1} in contrast of control seeds due to induction in Na^+ level. NS has high capability to decrease the harmful effect of Na^+ on seed germination. Beside it NS doses induced the GS value in case of presence or absence of Na^+. When there is no Na^+ in germination medium, GS raised from 17.3 to 24.6 germinant day^{-1} after adding 300mg L^{-1} of NS. Three hundred million per liter of NS raised GS by 22.6% under the 5000mg Na L^{-1}. Correlated to treatment that got zero NS at same level of Na^+.Increasing level of Na^+ negatively affect the shoot length of common bean seedling. At the absorption of 5000mgNaL^{-1}, the seedling could keep growing. The highest shoot length was observed at 2000mgL^{-1} of Na^+ in absence of NS. In the interval, control seedling had a shoot length of 7.3cm but seedling at 5000mgNaL^{-1} didn't flourish, when more NS was added to growth medium even by 100, 200 and 300mgL^{-1}. Shoot length was higher when the seeds treated with different doses of NS.In the same way, root length was higher for seedling preserved under different doses of NS(100,200 and 300mgL^{-1}) i0n contrast to untreated seedling. Seedling were capable to grow only when they fulfilled with NS, getting highest root length at 300mgL^{-1} NS when seedling doesn't open to Na^+ stress.(H. Alsaeedi.et.al., 2017)Nanosilver shows drastic influence on efficiency of *pisum sativum* crops germination. All nanoparticles have their own properties effect on crops. But nanosilver particles are of a special interest. Nanosilver shows extreme increase in catalytic and biological activities (krutyakov et.al; 2008). With the size of 9.15nm, silver nanoparticles proved to be the most influencing in elimination of pathogenic microorganism (Agnihotri et.al; 2014).Silver nanoparticles show strong effect on seed of pisum sativum when treated with different form of silver nanoparticles. Pea seeds treated with different concentration of nanosilver (0.05, 0.01, 0.005, 0.001, 0.0005%) and then placed in incubator at 20ºc temperature. After 96 hours of treatment, germinated seeds were calculated. Each sample has 100 seeds in petridish filled with 20ml of solution. Root length was measured and differentiates with control. The control was certified in triplicate (50 seeds each test). The main parameter was the average root length and the percentage of germinated seeds.

In the result, it was found that there was no special impact of treatment with $AgNo_3$ on percentage of germinated seeds in total range of concentration and also confirmed that no specific effect found on germinated seeds at concentration 0.0005-001%. But when the seeds were treated with Ag DDAB, DDAB solution at concentration of 0.05% found a harsh decrease in % of germinated seeds and this shows a toxic effect of said agents.Net parameter that was determined was the growth of root. The form of nanosilver was stabilized with PVP indicate the best result in terms of root length as compared to control. The average root length is approx. 40mm at every concentration used. ANOVA results shows that the amount of Ag- PVP didn't influence the root length in present experiment, as Fisher pattern in lower than 2.5 (P=0.05).Ag-DDAB shows a positive effect on seeds. An average root length was approx. 4L and 34mm far said concentration respectively. When the amount of Ag-DDAB higher than 0.001% found a decrease in root length, showing the resistance of DDAB diluted solution. So from above result we found that silver nanoparticles effect seed germination at constant concentration (Barabanov. 2018, 715-719).

With an objective to study the effect of green synthesized saponin capped silver nanocrystal on germination and growth of root and shoot of plant. Beside this, firstly studied about green synthesis process through which toxic level of prepared nanocrystals may be reduced by capping the nanocrystal with non-toxic plant extract. Just a short time ago, a few authors stated that silver nanocrystal can be used for better growth of different seeds and can behave as a growth parameter in many seeds that are highly related to agriculture.

To study the effect of green synthesis saponin capped silver crystal on germination and growth of root and shoot. We have taken three types of seeds of three pulses such as *Pisum sativum, Cicer arietinum,* and *vigna radiate.* Many authors have stated that different NPs including Ag NPs can effect directly and indirectly on germination and growth of many seeds. For this study, the Ag NPs solution has been diluted extremely and then seeds have been treated with this diluted solution of Ag NPs. In this treatment, water is used as control. Later, a few trials had done with different concentration of Ag NPs. It has been found that the germination rate of seeds get considerably increased after treatment with Ag NPs (48, 52, 61-68) against the control. During this exact study with different concentration, a minimum concentration of Ag NPs has been found, which determined the lowest dose for effective germination and subsequent growth.

When AgNPs solution is added for the germination study to each Petri dish, some extract gets added to it and remain present in the sample throughout germination. So, to examine the effect of this little bit of extract, we have studied the germination of the seeds in the occurrence and the lack of approximately the same amount of extract in the water against the control. It has been observed that for germination, both cases have taken same time and also growth is almost same. Hence, this study confirms that there is no obvious effect of extract on the germination of seeds and successive growth processes. The root and shoot lengths have been determined with a scale for respective germinated seeds and also for each concentration. The trial study indicates that the lowest doses for significant germination for Pisum sativum, Cicer arietinum and Vigna radiata are $12 \times 10-4$, $23 \times 10-4$ and $07 \times 10-4$ ვ g/ml, respectively. Now, the most important part of the study is that, beyond a certain maximum dose of $95 \times 10-4$, $110 \times 10-4$ and $90 \times 10-4$ g/ml for the respective seeds, an unwanted effect of overdose of silver nanocrystals has been observed, where impulsive death of the seedlings has been observed.

Again, on differentiating with untreated plants, the mean germination time (in hours) has been observed to get decreased, which indicates a very positive reaction of silver nanocrystals respectively. Generally, the consequences of germination confirm that there is effect of silver nanotriangles on germination and succeeding growth. Furthermore, every seed has a pore-like opening called micropyle, the diameter of which is different for different seeds, but much bigger than the nanoparticles size. Hence, silver nanotringles can easily go through inside the seed through this micropyle, which may change the cell membrane of the seeds, along with other cell structures. So, this germination effect, along with the consequent growth processes, which takes place due to the interaction with the silver nanocrystals, may be attributed to the increase of water absorption abilities by all these seeds increase of nitrate reductase and to the promotion of antioxidant systems of seeds in the presence of silver nanocrystals. For this, silver nanocrystals play an important in the germination of all these seeds. (Babli Debnath, Sumit Sarkar, Ratan Das., 2019)

The cultivation of beans (Phaseolus vulgaris) constitutes one of the staple foods in Mexico and in many parts of the world. This grain is an excellent source of proteins, essential amino acids and iron; beans contribute approximately 40% of iron to the human diet, however, it has been estimated that, of the total iron present in beans, only up to 20% is assimilated, so their contribution is low (Escamilla, 2013). Iron (Fe) is a micronutrient, considered as one of the most important for plant life. It is a essential elements on many process but also help to improve nutrition and achieve food security.The effect of NPs of micronutrients like Fe and Zn in plants is now being investigated. It has been observed that nanoparticles can help with biological molecule delivery. plant cells, seed germination, and plant growth, among other things as well as improvements in herbicide application (Lin and 2007 (Xing).The purpose of this investigation was to assess the likelihood of establishing. For the estimation of the treatments, a linear model was used in a fully randomized design with three treatments (T, T1 and T2) and five repetitions. The counting of seeds that showed rupture of the seed coat (the greater the break of the seed coat, the larger the frequency of germination and the development of the radical), at 24 hours there are no major differences between treatments because the process of imbibitions lasts from 14 to 24 hours (Suárez and Melgarejo, 2010). A diversity of 36% higher than the control was obtained. This higher percentage of the testa break in T1 treatment that becomes constant after 48 hours, the T2 treatment at 48 hours has reduced in the percentage of SBT, while the treatment T compared to T2 at 24 and 48 hours greater than SBT (seed with breaking of testa), at the end of 120 hours the T1 treatment was found to have the largest percentage of SBT. T1 and T2 have presented more SDR (seed with radical development) than the control T, same capability that was shown until 120 hours. However, the T2 treatment is statistically equal to T at 120 hours. It is noticed that in many occasions, the seeds after their maturation and dispersion are not capable to germinate, either because they are inactive or because the environmental conditions are not favorable. In this condition the seeds begin to get worse which is manifested by the progressive loss of their ability to grow (viability) and give rise to healthy and hearty seedlings (vigor). The T1 treatment shows the best result of SDR every 24 hours, showing growth with significant differences with the rest of the treatments (T2 and T).

At the end of 120 hours, the length of the major roots of 50 seeds per treatment, chosen at random, was determined. The mean root length of the seeds was 15.1, 23.6 and 17.3 mm for T, T1 and T2 respectively. Seeds treated with 5 mg.L1 of NPs-FeG (T1) have longer roots, representing in treatment T1 26% higher than in T2 and 36% higher than the control T (Prieto-Méndez1.et.al., 2019).

The genus vigna included many legume crops of high economic vale in the world. It includes mung bean [Vigna radiata (L.) Wilczek; urd bean [Vigna mungo (L.) Hepper]; cowpea [Vigna unguiculata (L.) Walp.]; rice bean (Vigna umbelleta Thunb.); moth bean (Vigna aconitifolius); Bambara groundnut (Vigna subterranea); adzuki bean [Vigna angularis (Wild.) Ohwi & H. Ohashi]; Sarawak bean [Vigna hosei (W.G.Craib) Backer]; beach bean (Vigna marina), etc.Mung bean is one of the thirteen food legumes grown in India and third most essential pulse crop of India after chickpea and pigeon pea. To enhancing the yield and develop quality of mung beans, Titanium oxide nanomaterial is used. In plants, titanium stimulates manufacture of more carbohydrate, promote growth and photosynthesis rate (Choi et al., 2005; Owolade et al., 2008) [4, 14]. The most significant effects of Titanium compounds on plants are improvement of the yield of various crops (about 10–20%); an improvement of some essential element contents in plant tissues. Hong et al., 2005, Yang et al. (2006) reported that a suitable concentration of nanoTiO2 was found to enhance the growth and increase of spinach by promoting aged seeds vigor and chlorophyll formation. A major improvement was also observed in shoot length (17.02%), root length (49.6%), root area (43%) and total soluble leaf protein (94%) as a result of TiO2 NPs purpose by Raliya et al., (2015).The current project, consequently aims at estimation on the impact of TiO2 nano particle on germination and seedling characters in 3 varieties of mung bean – **Sonali, Panna, IPM 23.**

In control condition, biggest germination percentage was recorded in Sonali (83.33%) and lowest in Panna (80.00%) whereas IPM 23 recorded 81.67% germination. 10 ppm was observed as best concentration among all concentration of TiO2 nanoparticles. Panna recorded 96.67% of germination, Sonali recorded 93.33% of germination and IPM 23 recorded 95.00% of germination at 10ppm and there was no major difference with 20ppm (95.00%, 90.00% & 93.33% respectively).Highest root length was found in Sonali (12.71 cm) and lowest in Panna (11.67 cm) followed by IPM 23 (11.83 cm) as control. The most positive effect on root length was found at 10ppm of TiO2 nanoparticles in all varieties. At this absorption of 10ppm, Panna recorded 15.92 cm of root length, Sonali recorded 16.68 cm length of root and IPM 23 recorded 16.57 cm of root length, all followed by 20ppm equally (13.45 cm, 13.95 cm & 15.76 cm). There was no major difference across varieties for shoot length. Sonali was obtained longest shoot (13.99 cm) and exhibited no major distinction with Panna (13.96 cm) whereas IPM 23 recorded 13.60 cm of shoot length. 10ppm of TiO2 nanoparticles was found as best concentration for this character as all varieties performed their best at this absorption, Panna displayed most approving shoot length with 18.51 cm, Sonali recorded 19.59 cm length of shoot and IPM 23 was found to had 19.30 cm of shoot length; the performance outdated the equivalent shoot lengths obtained by 20ppm level respectively with 17.02 cm, 17.47 cm & 18.44 cm.

In control state, not much deviation was noticed for root fresh weight by all varieties. In such case, IPM 23 was found to have highest fresh weight of root (0.055 g) and displayed no major difference with Panna (0.054 g) whereas Sonali recorded 0.052 g fresh weight of root under control state. 10ppm of TiO2 nanoparticles was reported as best amount for this quality as all varieties given their best result at the same concentration; Panna recorded 0.080 g fresh weight of root, Sonali recorded 0.100 g of root fresh weight and IPM 23 was also found to had 0.100 g of fresh weight of root followed by 20ppm (0.077 g, 0.096 g & 0.093 g respectively). IPM 23 was found to have highest shoot fresh weight (0.107 g) and Sonali recorded lowest fresh weight of shoot (0.092 g) at par with Panna (0.094 g) in control condition. At 10ppm of TiO_2, Panna recorded 0.161 g of shoot fresh weight, Sonali recorded 0.130 g of shoot fresh weight and IPM 23 recorded 0.185 g of fresh weight of shoot followed by 20ppm in the same way the following values 0.153 g, 0.111 g & 0.179 g accordingly.

IPM 23 was found to have highest total fresh weight of seedling (0.164 g) and Sonali recorded lowest total fresh weight (0.147 g) at par with Panna (0.149 g) under control. At 10ppm of TiO_2, Panna recorded 0.241 g of total fresh weight, Sonali recorded 0.230 g of total fresh weight and IPM 23 recorded 0.288 g of total fresh weight of seedling followed by 20ppm (0.231 g, 0.220 g & 0.275 g accordingly) (Dr. Bhanu Priya, Dr. S Mukherjee and Dr. M Srinivasarao., 2020; 9(10): 107-112).

DFC (Dichlorofluorescein) is a natural, crystalline organic, coloring agent that substitutes for chloride at 2 and 7 positions and introduced in the fluoresce family. The molecular weight of dichlorofluorescein is 401.20 g/mol, a melting point of 280 °C and it is used as an indicator which is not prone to soluble, absorbs, breaks or infuses silver or halide ion, but changes color at the end of precipitate due to absorption process. DCF can be the reducing agent for metallic salt (iron, copper, zinc, silver, gold, etc.) for the development of metallic nanoparticles for various agriculture applications. Dichlorofluorescein silver nanoparticles (DCF-SNP) were used to study its effect on the germination of Mung Bean (Vigna radiata) seeds. The effect of difluorescein was observed at percentage germination, root and shoot length of mung bean plant. In the current research, the production of radicals more than 1 cm is interpreted to be positive growth or else indicated as harmful.The amount of dichlorofluorescein silver nanoparticles enhances the root and shoots length decline as compared to controls once. After

96 hrs, the Mung beans treated with 25% of dichlorofluorescein silver nanoparticles (DCF-SNPs) shows growth in root and shoot length when compared with the positive control. On the other hand, the concentration of DCF-SNPs increases from 50% to 100%, there was reserve growth observed when compared to 25% of dichlorofluorescein silver nanoparticles.

The consequence of dichlorofluorescein silver nanoparticles on seed germination of the Mung bean (V. radiata) was carried out and the size of root and shoot lengths were observed after every 24 hour. Percentage of seed germination was significantly affected by the addition of dichlorofluorescein silver nanoparticles (DCF-SNPs). The 25% concentration of DCF-SNPs treated Mung seeds indicates a tremendous growth at 72 hours. In detailed, the seed germination rate increases from 75% to 95%. At the same time, as the concentration increases from 50% to 100%, the growth rate get varies or unexpected.

Due to contacts of dichlorofluorescein silver nanoparticles, the percentage of germination and length of root and shoot certainly has been affected. The normal lengths of root are measure after 24 hrs, 48 hrs and 72 hrs and found to be 6.6 mm, 22.2 mm and 41.7 mm respectively. The research showed the normal length of root and shoot at 72 hours was maximum which are 41.7 mm and 9 mm respectively. In the current study, the dichlorofluorescein silver nanoparticles showed unexpected effects on root and shoot length when treated with the different concentrations of dichlorofluorescein silver nanoparticles (DCF-SNPs). Huge the concentration of nanoparticles may be certified to toxic level of nanoparticles which has been seen in current research that above definite level of concentration the seedlings react in different way and causes successive decrease in growth. Therefore, the 25% concentration of dichlorofluoresceine silver nanoparticles (DCF-SNPs) though shows positive effects on the seed germinations of mung beans (Deochand.et.al. 2021).

Magnetite nanoparticles are help to stimulate the growth of Soybean and alfalfa. The germination index of soybean and alfalfa was not majorly affected by any pre-sowing treatment. Iron accumulation in both chemical forms (as Fe_3O_4-NPs or Fe-EDTA) induced the shoot biomass growth in these legumes by about 40% ($p < 0.01$) and 20% ($p < 0.05$), respectively, with no differences among doses. Root fresh weight also improved due to the appliance of these Fe-containing compounds at pre-sowing, being the induced rate more prominent for Fe_3O_4-NPs than Fe-EDTA, but not affected by the dose. Alfalfa root length also induced around 50% in plants showing to these Fe-containing compounds, irrespective of the chemical form and dose ($p < 0.01$). on the other hand, soybean root length improved when

Fe3O4- NPs were applied only. Root surface enlarged very drastically both in soybean (~50% at both NPs doses, $p < 0.001$) and alfalfa (63% and 97% at NP50 and NP100, respectively, $p < 0.001$). Also, Fe purpose as Fe3O4-NPs or Fe-EDTA at pre-sowing induced chlorophyll content in both legume species. The highest enhance over the control was found under NP50 for alfalfa (26%) and under NP50 or NP100 for soybean (both 40%), $p < 0.001$(Florencia Iannone.et.al., 2021).

Conclusion

All nanoparticles particles have their own properties and purposes. Nanoparticles like iron, silver, magnesium etc they are commonly used nanoparticles in nanotechnology to improve the crop yield and germination. They affect plant in both ways in positive or negative ways. From the above result, it concluded that nanoparticles effect the growth, germination percentage, shoot length, Root length, and germination index of plant in a positive way. It has been seen that nanoparticles affect plant properties at a constant concentration. But when the concentration isn't suitable than the growth and germination of plant reduced or maybe they doesn't grow. Most commonly used nanoparticles are silver nanoparticles and it is a good growth stimulator for plants. It has seen in above result that silver nanoparticles are the most useful nanoparticles in agriculture. It increases the growth of plant at very high extent approx 85%. Some nanoparticles reduced the growth of plant and also they are toxic for crops yield and growth. They stop their enzymatic activities due to which they don't germinate. But if we treated seeds of a legume crop at a constant concentration, they achieve their extent growth and yield. Nanoparticles are also increases the growing speed of crop.

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