Impact of Silver Nanoparticles on onion (*Allium cepa* L.) seed germination and seedling Vigor.

Abstract

During a study on the influence of silver nanoparticles (AgNPs) on the growth of Arka Pragati onion varieties, AgNPs measuring 100 nm were used in five different concentrations (0, 25, 50, 75, and 100 ppm). The findings revealed that using 25ppm of AgNPs led to the highest percentage of seed germination compared to all other concentrations. Furthermore, this concentration showed a positive impact on seedling growth. On the other hand, all other concentrations had a harmful effect on both seed germination and seedling growth, with the level of toxicity being strongly associated with the concentration of the suspension. The lowest rate of seed germination was observed with a concentration of 100ppm of AgNPs, however no significant difference was found between 75ppm and 100ppm concentrations. Therefore, a concentration of 25ppm of AgNPs proved to be the most effective treatment for promoting optimal seed germination and seedling growth in onions.

Keywords: Onion, Germplasm, Nanoparticles and Vigor

Introduction

Onion (*Allium cepa*) are an important bulb crop and a key vegetable in India. It belongs to the family *Alliaceae*. The *Alliaceae* family includes several more economically substantial crops, such as garlic (*Allium sativum*) and leeks (*Allium ampeloprasum*). It contains anti-lacrimal agents, solid anti-bacterial agents, anti-fungal agents, bacterial, anti-cholesterol agents, anti-cancer agents, and antioxidant components such as quercetin (Baghizadeh et al.) In expansion, it has been detailed to be wealthy in phytochemicals particularly flavanols which has therapeutic esteem (Javadzadeh*et al*. 2009). Within the World, India positions moment in range and generation of onion following as it were to China. In add up to trade of vegetables from India, onion has the biggest section of send out bookkeeping to 76.2 per cent. But efficiency is much lower than numerous of the nation. There are many rules for increasing efficiency. Unavailability of high-quality onion germplasm is one of the main reasons for low yields. Seed quality parameters, especially seed size and seed weight, influence the ultimate reduction in onion yield (Gamiely et al., 1991).

Moreover, tall quality seed is considered as a basic input in onion on which all other inputs got to be overseen for potential abdicate in onion. In India onion is developed in a zone of 1.01 m ha with a generation of 16.8m tons having efficiency at 16.6 t ha-1. The major onion developing states are Maharashtra, Gujarat, Uttar Pradesh, Orissa, Karnataka, Tamil Nadu and Andhra Pradesh. Onion seed rapidly misfortune its reasonability due to the generation of free radicals by lipid peroxidation amid capacity which result in moo germination rate. Display advances are not proficient sufficient to overcome this issue in expansive scale but nanotechnology may bring a beam of trust to overcome such issue. Nanoparticles appear diverse impacts on seed germination of distinctive plants (Rico, et al. 2011). Poisonous quality thinks about, both positive and negative impacts was watched when a few

higher plants were treats with of a few nano particles viz. TiO2, ZnO, Mg, Al, Pd, Cu, Si, C60 fullerenes, and multiwall carbon nanotubes (Monica and Cremonini, 2009). (Senthilkumar, 2011) and (Sridhar, 2012) watched that metal oxide nano-particles are effective sufficient to move forward the germination of matured germplasm of dark gram and tomato up to 30 per cent individually. This may well be likely due to the quenching of responsive oxygen species (ROS) produced amid seed capacity. Zhang et al., 2006 detailed that applications of nanotechnology move forward seed germination, rise and development of seedlings. Consequently, the display examination was made to consider the impact of AgNPs on seed germination of onion seed.

Materials and Methods

AgNPs with particle less than 100 nm were used. Onion germplasm (L-883) purchased from National Horticultural Research and Development Foundation (NHRDF), Centre Indore, Madhya Pradesh was selected for the experiment. AgNPs of strengths of 25 ppm (T1), 50 ppm (T2), 75 ppm (T4), and 100 ppm (T5) were prepared in distilled water using a water bath as treatments. The experiment was conducted following a completely randomized design (CRD) with four replicates. For each treatment, 50 germplasm were placed in each replicate. To ensure surface sterility, germplasmwas soaked in a 5% sodium hypochlorite (NaCLO) solution for 20 min (USEPA, 1996) and subsequently washed several times with distilled water. Using a solution that contained AgNPs, the experimenter submerged 200 germplasm in the treatment solution for approximately 3 hours. As supplementary control, he kept them in distilled water for the same period.

Put it in distilled water for a period. The container was frequently shaken to ensure uniform adsorption of AgNPs. A Borosyl Petri plate with a diameter of 100 x 15 mm was placed in a Whatman no. A piece of filter paper and 2.5 ml of treatment solution was poured onto it, and the control was treated with 2.5 ml of double-distilled water. These Petri dishes were then placed in a germination chamber at 25 ± 2 ℃ and 95 ± 3% relative humidity. Germination was recorded daily, further observations were made every 6 days, and the last observation was made on the 14th (ISTA, 2005).

Parameters measured in this study were:
Germination Percentage (GP %) = (Gs/n) × 100
Where Gs is the total number of germinated germplasm and n is the total number of seed used in the test.
Cumulative germination percentage was also calculated by counting the cumulative germination against each day.

Germination rate index (GSI)

The germination index was calculated as the total number of germplasm germinated per day divided by the number of days from sowing to germination, according to the Maguire equation (1962).

Mean germination Time (MGT)

Mean germination time was calculated by the formula given by (Ellis, 1981)

MGT = n1 x d1 + n2 x d2 + n3 x d3 + --------/ Total number of days

Where, n= number of germinated seed

d = number of days

Mean daily germination (MDG)

Mean daily germination can be calculated by the following formula given by (Czabator, 1962)

MDG = Total number of germinated germplasm/ Total number of days

Vigour index

The vigor index was calculated using the approach recommended by Abdul-Baki and Anderson (1973) and was given as a whole number.

Vigour index = Germination percentage × Seedling length.

Tolerance Index (TI) = Average root length in AgNPs solution divided by longest root length in control solution x 100. (Saeed & Associates, 2016)

Root and shoot length

The measurement of the root length from the base of the collar to the tip of a root was done for all normal seedlings, and the average value was in centimetres. The average value for the shoot length of normal seedlings from the germination test was measured on the 6th and 14th days, respectively, from around the collar area to the tip of the shot. A similar approach was taken to determine root-to-shoot ratios. Fresh mass was quantified by weighing on a precision balance equipped with an electronic balance and expressed in mg. Fresh seedlings were placed in an oven at a temperature of 70 °C until the weight was constant, and the weight was expressed in mg.

Result and Discussion

In this study, a significant increase in germination percentage (GP) was observed at T1 (25 ppm AgNPs) compared to all other treatments (Table 1). Gradual higher concentration of silver nanoparticle effect the GP and lowest GP wasobserved in 100ppm of AgNPs in both the observation. Maximum germination speed index was observed in 25ppm whereas T3 and T4 was at par but significantly less then control (table 1).A cumulative germination percentage of percent (CGP) means that germination started on day 3 for all treatments, but for T4, the first germination was observed on day 4. From the cumulative germination rates,

it can be concluded that T2, T3, and T4 were partially toxic to the seedlings and therefore the CGP increased slightly.

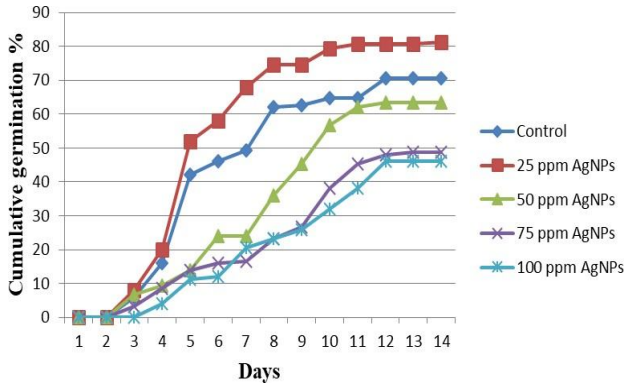

Figure 1: Cumulative germination percentage of germplasm treated with AgNPs.

Observed in initial days where as a rapid increase in CGP was observed in T1 and control (Fig 1). It may also notice that seed of T2 could manage them self to pick the germination after 7 days. On the other hand, mean germination time was non-significant. Among all the treatment.

Table1: Meanperformanceofonionseedforgerminationandvigourparameters.

Treatment	Germination %		GerminationspeedIndex	Meangerminationtime	Meandaily germination		Vigorindex	
	6th day	14th day			6th day	14th day	6th day	14th day
Control	46.00^{b}	70.66^{b}	6.60^{b}	2.23	3.83^{b}	2.52^{b}	155.34^{b}	641.35^{b}
T1	58.00^{a}	81.33^{a}	7.98^{a}	2.36	4.83^{a}	2.90^{a}	235.86^{a}	871.16^{a}
T2	24.00^{c}	66.00^{b}	4.87^{c}	2.46	2.00^{c}	2.26^{c}	62.48^{c}	500.78^{c}
T3	16.00^{d}	50.00^{c}	3.6c^{d}	2.03	1.33^{d}	1.73^{d}	17.07^{d}	250.42^{d}
T4	12.00^{d}	46.00^{c}	3.12^{d}	1.99	1.00^{d}	1.64^{d}	7.25^{d}	216.42^{e}
CD(0.05)	6.30	5.05	1.81	NS	0.52	0.19	19.96	28.71
SEm	2.00	1.60	0.28	NS	0.14	.06	6.33	9.11

The average daily germination was significantly higher on days 6 and 14, but the average daily germination on day 6 was higher (4.83) than on day 14 (2.90). This means that 25 ppm AgNPs stimulate early germination, but the data show that 250 ppm, 75 ppm, and 100 ppm AgNPs of populate early germination (Table 1). Treatment with 25 ppm AgNPs showed the maximum vitality index (VI) on days 6 and 14, which was significantly higher compared to the control.The VI was gradually decreased with incrassating concentration of AgNPs i.e. 50, 75 and 100ppm respectively. Lowest concentration of VI was observed on T4 (Table 1). It is also.

Table2: Meanperformanceofonionseedfortoleranceindex,shootandrootratio,seedlingfreshweightandseedlingdryweight.

Treatment	Toleranceindex		Shootandrootratio		Seedlingfreshweight(mg)	Seedlingdryweight(mg)
	6th day	14th day	6th day	14th day		
Control	100.00^{b}	100.00	2.46^{a}	3.72^{b}	20.27$_{b}$	1.50
T1	140.61^{a}	120.57	1.97^{b}	3.64^{b}	25.89$_{a}$	1.71^{a}
T2	105.85^{b}	94.47	1.50^{c}	3.51^{b}	21.40$_{b}$	1.09^{d}
T3	76.39^{c}	51.90	0.45^{d}	5.04^{a}	16.47$_{c}$	1.52^{b}
T4	58.13^{d}	52.37	0.27^{d}	4.67^{a}	17.50$_{c}$	1.30^{c}
CD(0.05)	11.64	10.32	0.27	0.63c	1.29	0.17
SEm	3.27	3.21	0.2	0.08	0.4	0.05

Important to draw the attention that treatment T2, T3 and T4 had very little VI compare to T1 or control in 6th day, which reflect the minimum growth in the initial days. On the other

hand, highest tolerance index (TI) is observed in case of T1 and least was observes in T4. (table 2) The decrease in TI and VI are due to greater inhibition of seed germination percentage followed by root length and shoot height in response to the composite adverse effects of metal toxicity like AgNPs by oxidative stress.The metal toxic effects of AgNPs on plants have been previously studied, and the enzymatic and non-enzymatic antioxidant components in AgNPs, namely peroxidase, catalase, superoxide dismutase, malondialdehyde, and high free amino acid content. (Mehrian et al, 2015).Those may be the factor for the same. Seedling fresh weight was significantly higher over all other treatment in T1 (25.89 mg) whereas lowest Seedling fresh weight was recorded in T3 but it was at par to T4. Similarly highest dry weight was recorded in T1 but surprisingly lowest dry weight was recorded in T2. It was noticeable that shoot length was very less in T4 and T3 compare to other treatment (Table 3) however maxima shoot length was observed in T1 which was Significantly higher than all other treatment. Similar result was observed in root length. Highest root length was observed in T1 and minimum root length was observed in T3 but it was statistically at par with T4 (Table 3.) Yin et al, 2011 reported that root and shoot growths are more affected by the Ag treatment than seed germination.Exposure of *Phaselous radiatus*, *Sorghum bicolor*, and Lolium multiflorum to silver nanoparticles decreased root growth, root length, and biomass (Lee et al., 2012).

Conclusion

All parameters clearly indicate that low concentrations (25 ppm) of AgNPs promote germination and also positively affect various physiological activities, but high concentrations of AgNPs are toxic to seedlings. Among all treatments, T4 was the most toxic to seedlings. 100 ppm AgNPs significantly reduced almost all parameters. The toxic effect of AgNPs could be due to the presence of nanoparticles and, secondly, the release of Ag+ ions from nanoparticles and the formation of free radicals in AgNP suspension (Asharani et al., 2008). Researchers have also demonstrated that AgNPs can disrupt cell division processes, causing chromatin cross-linking, stickiness, and cell collapse (Kumari et al., 2009).

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