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Effects of *Alternanthera sessilis* (L.) R.Br.ex DC. in the presence/absence of silver nanoparticle (Ag-NPs) on the performance of jowar (*Sorghum vulgare*)

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Abstract

Weeds have not been given enough attention, and their utility in agriculture has not been widely considered**.** Nanoparticles (NPs) are tiny particles having size ranges from 1-100 nm. In plants, NPs exerted negative as well as positive effects, depending upon the type and concentration of NPs as well as plant species. The objective of the current study was to observe the effect of *Alternanthera sessilis* and silver nanoparticles (Ag-NPs) alone as well as in combination on the performance of jowar (*Sorghum vulgare*). A laboratory experiment was performed in petri plates with 3 replicates (20 seeds in each petri plates) of each treatment in the Lab of Botany Section, School of Sciences, Maulana Azad National Urdu University, Hyderabad. *A. sessilis* (50%) and Ag-NPs (50 ppm) application was given to the petri plates containing jowar seeds. After 3rd day of germination, seedling growth (shoots and root length), germination index, and vigor index of jowar seeds were calculated. The results showed the positive effects of *A. sessilis* and significantly increased all the aforesaid parameters, however, Ag-NPs exerted negative effects. One very promising result came when *A. sessilis* applied in the presence of Ag-NPs; it slightly reduced the toxicity caused by Ag-NPs in jowar seeds. In conclusion, we can say that *A. sessilis* used to mitigate the toxicity caused by Ag-NPs.

Key words : Silver nanoparticles, *Alternanthera sessilis*, *Sorghum vulgare*, Toxicity.

In agriculture, the idea that one plant can affect another's growth is well-known. When released into the environment, the secondary metabolites produced by plants (donor) have a significant impact on the ecology, physiology, and growth of other

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nearby plants (recipient)[12]. Allelopathy is described as the impact of one plant on other plants caused by the release of chemical substances into the environment by plant physiologist Hans Molish of the University of Vienna, Austria[3]. According to[12] almost all allelochemicals are classified as secondary metabolites of the plant[22] and depending upon the compound content, they can either stimulate or inhibit the growth of other plants[4]. Allelochemicals have been found in all plant parts, but their concentration varies all across the plant. At various phases of growth, heredity and environmental variables both play a significant role in controlling the synthesis of allelochemicals[28].

A plant that the farmer did not sow in the field and that grows in un-needed places is referred to as a weed. These undesirable plants may endure harsh environments despite being unwanted and unattractive. When people started purposefully cultivating plants for food and other uses, the idea of weeds as undesirable vegetation came into being. They are bad for people, cattle, and plants. They can grow larger than valued crops due to their robust and healthy development, which depletes soil moisture and nutrients that would otherwise be available to preferred crops. These are undesirable plant species that are encroaching on domesticated crops[16].

NPs are micro-elements that are extremely fine in nature with size ranging from 1-100 nm in at least two of their dimensions. NPs extend the benefit of the efficient release of agro-chemicals because of their very high ratio to surface area to volume and quick mass relocation. The current study has focused on understanding how NPs affects plant and other living things[2]. In physics, chemistry, agricultural science, environmental science, and medicine, NPs are widely employed[18]. On the uses of NPs with regard to absorption, uptake, accumulation, transformation, and their effects in fewer plant species, many and contradicting experiments have been documented[24]. The ionic material from industrial discharge clusters and transforms into nanoparticles after reduction, where it can be absorbed by plants in a variety of ways[1].

Plants, chemicals and seeds :

Ag-NPs were purchased from Nano Research Lab-Jamshedpur. Alternenthera weed was collected from the campus, Maulana Azad National Urdu University, Hyderabad and mature seeds of jowar were collected from institute of Millet research-Hyderabad. Distilled water was used for the experiment.

Preparation of root extract :

The plant root extract solutions were prepared by taking roots of Alternenthera plant and drying at room temperature. These roots were ground into a fine powder. 10g of fine powder was soaked in 200ml distilled water for about 48 hours. The extract was filtered with Whatman no.1 filter paper, filtrate stored at low temperature. Then 50% aqueous extract was prepared and used for further experiment.

Experimental design :

Seeds of jowar were surface sterilized with 2% sodium hypochloride then washed with distilled water. 20 seeds were placed in sterilized petriplates with filter paper. Each petriplates was treated with 4ml of 50%

Fig. 1. Chemicals and seeds used in the present experimental work.

prepared root extract of Alternenthera, 50ppm AgNPs and mixture of both root extract and AgNPs. Controlled petriplates were treated with 4ml distilled water. Each concentration was prepared in three replicates, along with a control. These petriplates were kept in BOD incubator at room temperature. After 48 hours germinated seeds were counted and after 3rd day of germination, seedling growth (shoots and root length), germination index, and vigor index of jowar seeds were calculated.

Germination index :

Germination index = %germination/Days of germination

Vigour index :

Vigour index = % germination x mean of seedling length (root+shoot).

Germination percentage :

$$\frac{\text{Number of seeds germinated}}{\text{Total seeds}} \times 100$$

Supplementation of Ag NPs negatively affects the %germination of jowar. However, application of alternenthera in the presence/ absence of silver nanoparticle enhanced the %age germination over only silver nanoparticle treated seeds (Table 1, Figure 2).

Shoot and root length :

Silver nanoparticle inhibits the root and shoots length of jowar seeds and alternenthera sessilis enhances the same when treated alone, but when alternenthera sessilis is treated along with silver nanoparticle on jowar seeds it reduces the inhibitory effect of silver nanoparticle (Table-1, Fig 3).

Germination index :

Both *Alternenthera sessilis* and silver nanoparticles inhibit the germination index of jowar seeds when treated alone. However when alternenthera sessilis is treated along with silver nanoparticle it reduces the inhibitory

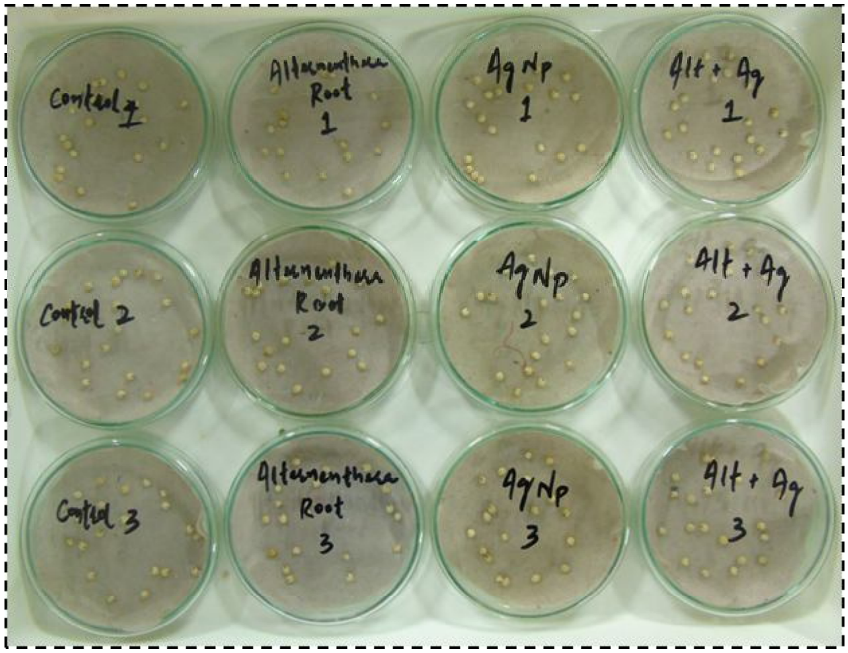

Fig. 2. Effect of Ag-NPs and *Alternanthera sessilis* on seed germination of jowar.

Fig 3. Effect of Ag-NPs and *Alternanthera sessilis* on shoot and root length of jowar.

Table-1. Effect of *Alternanthera sessilis*, Ag-NPs and *A. sessiliis* + Ag-NPs on the seed germination, and growth parameters of *Sorghum vulgare*

Parameters/ treatments	% germination	Root length	Shoot length	Germination index	Vigour index
Control	98.33	10.36	6.23	49.33	163.17
Alternanthera sessilis	95.00	10.76	7.03	47.50	169.10
Ag-NPs	91.66	7.23	5.70	45.83	120.54
Alternanthera sessilis + Ag-NPs	96.66	8.20	6.00	48.33	137.24

effect of silver nanoparticle on jowar seeds (Table-1).

Vigor index :

Alternenthera sessilis in presence/ absence of silver nanoparticle enhances vigor index of jowar seeds in comparison of silver nanoparticle when treated alone on jowar seeds (Table-1).

There is a lot of uncertainty around the impact of NPs on seed germination, even though NPs have frequently been proven to either boost or have no impact on seed germination[7,11,17,25]. Only few researchers have documented how NPs harm seed germination[13,21]. The exposure concentration of copper NPs was adversely correlated with the seedling lengths of *Phaseolus radiatus* and *Triticum aestivum*, *P. radiatus* was more sensitive to Cu NPs than *T. aestivum*, and even necrosis was discovered in *P. radiatus* exposed roots. Root growth was found to be a more sensitive endpoint than shoot growth when *T. aestivum* growth was measured by shoot and root length[14]. Most of the time, our study agrees with the second group. From the results, it is much cleared that the treatment of Ag-NPs caused great inhibitory effect on seed germination, germination index, and vigor index over control. Decreased in seed germination and seedling development of *Sorghum vulgare* under Ag-NPs may severely impair its ability to compete for access to resources, particularly sunlight, which may be a crucial environmental factor affecting the development, growth, and survival of plant species[15,19]. Ag ions produced by Ag-NPs are thought to be a possible mediator of one of the primary mechanisms of Ag-NPs toxicity[8,9,23,29].

Many studies have been conducted on allelopathy in cereal plants, emphasizing both beneficial and detrimental effects. Bhowmik and Doll also discovered that many annual weeds inhibited the growth of soybean seedlings[5] and with various weed extracts on various legume crops[27]. Some studies have shown the positive effect of weeds like leaf length, leaf width, and seedling biomass (fresh weight) of lettuce treated with low and high doses of *Canada goldenrod* leaf extracts is considerably increased. In light of this, *Canada goldenrod* (*Solidago candensis*) leaf extracts (particularly at low doses) may also be beneficial for lettuce seed germination and seedling growth. This might be explained by the low levels of allelopathic generated by

Canada goldenrod leaf extracts, which may have encouraged the reactive oxygen molecules in plant cell expansion, boosting lettuce seed germination and seedling development[6,20]. In other words, the lighter stress caused by the lower concentration of allelopathic generated by invaders may encourage the growth of native plant species[10,26]. So, it is not surprising that the modest concentration of alternenthera root extracts in this study increased root and shoot length, vigor index of jowar seeds and inhibited % germination and germination index.

In this study, both AgNPs and *Alternenthera sessilis* root extracts posed significantly negative effects on the % germination and germination index, however weed extract stimulated the root length, shoot length and vigor index and its opposite was seen in AgNPs. Hence, their interaction may have a synergistic impact on seed germination and seedling growth of *Sorghum vulgare*.

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