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Booklets



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Title: Evaluation of the effects of the use of silver nanoparticles as growth promoters of corn (Zea mays) and barley (Hodeum vulgare)

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Introduction

Synthesis of new products to improve physicochemical properties of materials (durability, strength, reactivity, conductivity).

Use of nanoparticles (Np's) in agriculture to promote plant growth as fertilizers at nanometer scale and with antimicrobial effects.

Contribute to the detailed study of agricultural substances to maximize production and obtain faster crops without bacterial diseases.

Methodology

1.- Germination with Silver Nanoparticles (AgNp's):

Seed Preparation:

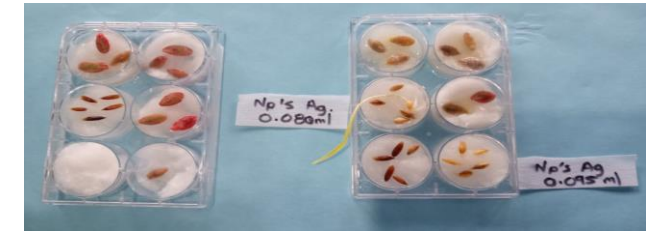
- Greenhouse germinated corn and barley.
- Washing with sodium hypochlorite and double distilled water.
- Placement of seeds in Petri boxes on cotton.

Synthesis of AgNp's:

- Green chemistry according to the methodology of Granados Olvera et al. (2023).
- Three concentrations of dilutions: 800, 950, and 1000 μ l/500ml.

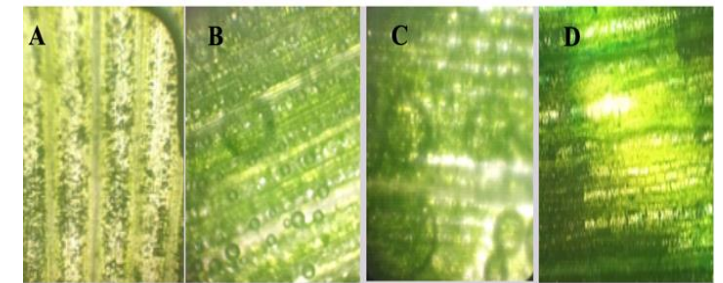
Experiment:

- Application of dissolutions in Petri boxes (1.5 ml per seed).
- Control conditions: water, light, temperature (26-30°C).
- Transplanting to substrate (peat moss) on the tenth day, with the addition of 3 ml of solution.



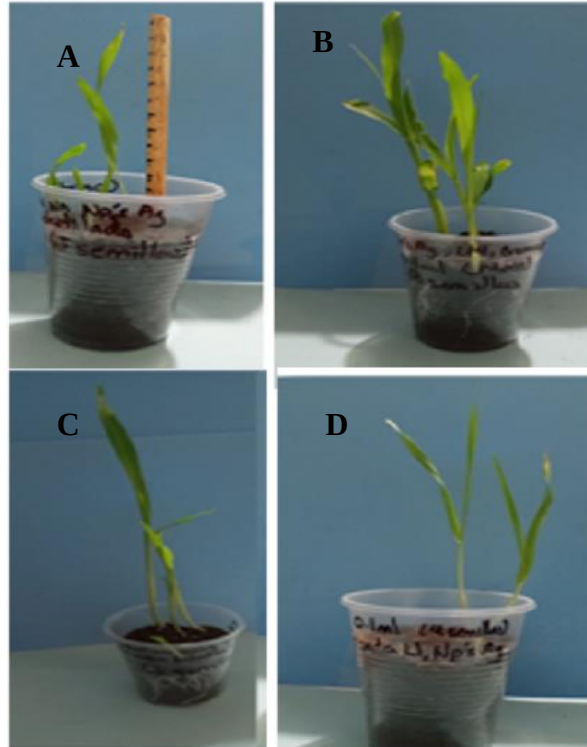
Germination test of corn (*Zea mays*) and barley (*Hordeum vulgare*) at 800 μ l and 950 μ l AgNp's concentrations where the growth of plumule and mesocotyl nodes can be observed.

Source: Own elaboration



No morphological alterations were observed in any of the samples. A) Barley with AgNp's supply B) Barley control, C) Corn with AgNp's supply D) Corn control.

Source: Own elaboration



Seedling at concentrations of 1000 μ l of Ag Np's/500 ml of double distilled water (A) Maize (*Zea mays*) control and (B) Maize irrigated with Ag Np's (C) Barley (*Hordeum vulgare*) control and (D) Barley (*Hordeum vulgare*) irrigated with Ag Np's.

Source: Own elaboration

2.- To evaluate biomass and photosynthetic characteristics of seedlings.

- Leaves of seedlings (treated and control) macerated with ethanol/methanol and filtered with acetone. Incubation and centrifugation for chlorophyll and carotenoid extraction.
- Total chlorophyll determined by spectrophotometry at 645 and 662 nm.
- Total carotenoids determined at 470 nm.
- Phytotoxic effect by calculation of seed vigor and germination percentage.
- Morphological observations of treated and control seedlings.

Results



Seeda	% de Germinat ion	% of seed vigor	Disolution	Seedling growth 15 days	
			(µl/ml)	Height (cm)	Depth (cm)
Corn (Zea mays)	72%	72%	800/500	37	34
			950/500	35	28
			1000/500	40	27
Barley (Hordeum vulgare)	50%	50%	800/500	15	18
			950/500	18	16.5
			1000/500	22.5	14
Corn Control	73.33%	73.33%	Double distilled water without Ag Np’s	14.5	21.5
Barley Control	73.33%	73.33%	Double distilled water without Ag	5	16

Determination of germination percentage and seed vigor percentage, evaluation of seedling height and depth (length).

Determination of leaf area, damaged area and % severity in experimental and control units.

Germination 2-4 days	# of leaves	Total seedling area	% of seedling severity	
Seedling of 40 days	Seedling	Evaluation (cm ²)	Damage area (cm ²)	% of severity
Corn 800 µl Np's Ag	6	14106	15	0.04602
Corn 950 µl Np's Ag	6	26795	150	2.6337
Corn 1000 µl Np's Ag	6	26361	205	4.1579
Barley 800 µl Np's Ag	3	11185	163	1.4573
Barley 950 µl Np's Ag	3	11366	357	3.14094
Barley 1000 µl Np's Ag	3	10255	146	18.1656
Corn control	6	4104	4	0.0974
Barley control	3	29894	1089	3.6428

Determination of total carotenes, chlorophyll and Margalef index.

Seedling	Total Carotenes (g/L)	Chlorophyll on a leaf area basis CHL (mgm^2)	Margalef index (g/L)
Corn	0.0000016	32.5742	1.7273
Barley	0.0000004	28.3074	1.4000
Corn control	0.0000036	17.5154	1.7600
BarleyControl	0.0000040	15.2563	1.6000

Conclusions

- Plants treated with AgNp's show better germination and higher root density than control plants.
- Improvement in the physiological, biochemical and genetic activity of plants, supporting a better agricultural yield.
- AgNp's linked to increased cytokinins, gibberellins and ethylene, which affect cell division and stress response.
- No significant morphological alterations were observed in AgNp-treated seedlings.
- Irrigation with AgNp's helps cell senescence without damaging cells.

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