International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 2.102

To Assess the Impact of Heavy Metals on Seed Germination in the *Raphanus sativus* Pusa Himani Variety under Laboratory Conditions

Dr. Rajshree Gupta

Professor, Botany, B. B. D. Govt. College, Chimanpura, Shahpura, Jaipur, India
Email: *rajshreegupta[at]rocketmail.com*

Abstract: ***Cultivators adjacent to industries irrigate their crops with polluted water from factories. This has resulted in a colossal damage to their crops. Rivers and soils have been polluted by heavy metals, produced due to industrial, agricultural and domestic waste. These heavy metals are toxic to crop plants. Heavy metals are hazardous pollutants as they are toxic, often accumulated and even biomagnified by plant parts including seeds. I used five concentrations (10, 50, 100, 200 and 500 ppm) of five different heavy metals viz Cu, Cd, Pb, Ni and Zn, (and control) in the present investigation, determining their toxicity effect on seed germination of Raphanus sativus variety Pusa himani. Raphanus sativus L. belonging to the family brassicaceae is a very popular root crop grown throughout India and is commonly known as muli. Pusa himani is a European or temperate variety of Raphanus sativus (radish). The best characteristic of this variety is the root formation even at 112 degree F temperature. It matures in 30 - 35 days. On the 11th day of the present research work, a number of seeds which showed germination were recorded. The average values of triplicate experiments were tabulated. The seed germination in Raphanus sativus variety Pusa himani was badly affected by the application of heavy metals. At 10 ppm concentration nickel (Ni) showed the same seed germination as in control that is 95% but it decreased to 93% (copper), 80% (cadmium), 85% (Lead), and 90% (Zinc) by the application of other heavy mheavyetals at this concentration over control. The sequence of heavy metal hazardousness towards germination of seeds was found to be Cd > Pb > Zn > Cu > Ni. The various treatments differed significantly among themselves and also with control.***

Keywords: Raphanus sativus, Pusa himani, Laboratory experiments, Petri dishes, Statistical analysis

1. Introduction

Soil samples of industrial, agricultural and residential areas have been found more concentrated with metallic elements viz. Hg, Cu, Pb, Cr, Cd, Ni, Fe, Co and Zn.

Due to high concentrations of these metals in these areas vegetation gets contaminated. Toxic impact of harmful metals on plants has been extensively observed.

In different plants, the absorption and transfer of heavy metals is concerned with their concentrations in the soil, plant species and cultivar characteristics, nature and age of plants and surrounding environment.

Metallic elements such as Cu (copper), Co (cobalt), Zn (zinc) and Ni (nickel) are some necessary micronutrients needed in trace quantities by plants to fulfil their development. Whenever their concentrations in the soil exceed trace levels, heavy metals can be extremely toxic.

Silver, mercury, cadmium, lead, and chromium are non - nutrient toxic metals. Nowadays, air, water and soil pollution have become a widespread issue, so it would be valuable to find out the role of toxic metals on seed germination of plants.

2. Material and Methods

Raphanus sativus L. variety Pusa himani, a vegetable cropof India was chosen as an experimental material for the present investigation.

Variety Pusa himani of Raphanus sativus was released by IARI, New Delhi and developed by hybridization. It is suitable for spring (Dec. - Feb.). The length of the roots are thirty to thirty five centimetres long and the width is ten to twelve centimetres. with whitish green shoulders (stem end or top). The best characteristic of this variety is the root formation even at 112 F' temperature. It matures in about 30 - 35 days.

For the present research work seeds of variety Pusa himani of Raphanus sativus were treated with 0.1% $HgCl_2$ for surface sterilization for 2 minutes and rinsed several times with distilled water.

Previously seeds were stored in glass stoppered containers. For uniformity of seeds (for colour and size), there was a preliminary selection of seeds. Different solutions of several concentrations (10, 50, 100, 200 and 500 ppm) of $CuSO_4$, $CdCl_2$, Pb $(NO_3)_2$, $NiSO_4$, $ZnCl_2$ were taken. Sixty seeds were immersed in these solutions for two hours, and for the control condition seeds were soaked in distilled water.

After this, seeds were shifted to wet filter paper in petri dishes in three replicates under laboratory conditions of diffuse light and 25+/ - degree Celsius temperature.

The experiments were conducted for ten days, irrigating the seeds daily with distilled water for progress. On the eleventh day of the experiment, the number of germinated seeds (average values of triplicate) were recorded and tabulated. Data was analysed statistically at 1% and 5% level of significance.

3. Result and Discussion

Data on the effect of heavy metals on the seed germination rates of cultivar Pusa himani of Raphanus sativus were tabulated (as shown in Table 1). The analysis of variance (ANOVA) for seed germination was carried out for testing the significant differences among control and various concentrations of five heavy metals, among chemicals and also among different concentrations (treatments).

Table 1: Showing the effect of heavy metals on seed germination in Raphanus sativus variet Pusa himani.

S. No.	Name of the chemical	Concentrations (ppm)					
		Control	10	50	100	200	500
1	Copper sulphate	95	93.3	86.6	80	70	56.6
2	Cadmium chloride	95	80	63.3	56.6	46.6	35
3	Lead nitrate	95	85	70	65	55	43.3
4	Nickel sulphate	95	95	90	83.3	75	63.3
5	Zinc chloride	95	90	81.6	75	63.3	53.3

(Values represent the mean of three replicates)

Analysis of Variance:
F - ratios:
(i) Control Vs Treatments = 47.7248***
(ii) Among Treatments = 16.3328***
(iii) Among Chemicals = - 3.8202 (Ins)
*** = highly significant

At 10 ppm concentration nickel (Ni) showed the same seed germination as in control that is 95% but it decreased to 93% copper (Cu), 80% cadmium (Cd), 85% Lead (Pb), and 90% Zinc (Zn) by the application of other heavy metals at this concentration over control. The order of heavy metal toxicity towards seed germination was Cd > Pb > Zn > Cu > Ni. The various treatments differed significantly among themselves and also with control.

Significant reductions in germination were seen at 100 & 500 ppm of Zn, 500 ppm of Ni, and 200 & 500 ppm of Cu, and at concentrations from 50 - 500 ppm of Pb. For cadmium, a reduction in germination was seen even at 10 ppm, increasing up to 500 ppm in the Pusa Himani cultivar of Raphanus sativus. Out Of the five heavy metals studied, cadmium and lead showed higher toxicity compared to copper, nickel, and zinc regarding their effects on seed germination in the radish variety Pusa himani.

Research has shown the importance of certain enzymes during germination, which can be greatly impacted by pollutants in wastewater. Reduced and delayed germination in *Cicer arietinum* and *Brassica campestris* species, due to higher levels of industrial effluents, could be linked to how these pollutants affect enzyme activity.

Heavy metals are toxic due to their ability to cause oxidative damage to tissues. This damage includes increased breakdown of lipids, oxidation of protein structures in sulfhydryl groups and DNA damage.

The inhibitory effects of toxic metals on seed germination of R. sativus variety Pusa himani are in agreement with the prior reports where germination inhibition was observed with heavy metals (4, 5, 6).

Several workers have studied the adverse effect of higher concentrations of industrial effluents on the yield, growth, and chemical makeup of various crops (7, 8).

Plants cope with internal stress and survive toxic heavy metal concentrations by adapting through several mechanisms (9).

In Sorghum sudanense, the plant sensitivity to heavy metals application was found to be in the order of Cd>Pb>Zn (10) which is in conformity with the present research work.

4. Conclusion

All the heavy metal pollutants considered in the present work were found to be inhibitory to seed germination of the cultivar Pusa himani of Raphanus sativus. Copper and nickel were found to be less toxic to seed germination in comparison to zinc, cadmium and lead. The concentration of 500 ppm of nickel (Ni), 100 to 500 ppm of zinc (Zn), 200 & 500 ppm of copper (Cu), and from 10 to 500 ppm of cadmium and lead were found to be most toxic to seed germination of Raphanus sativus variety Pusa himani.

Statistical analysis showed that there were very highly significant differences between control and various treatments of heavy metals to seed germination of Raphanus cultivar.
An overall assessment revealed that the cultivar Pusa Himani of Raphanus sativus was very sensitive to heavy metals toxicity.

The present study has ecological implications as the co - occurrence of copper, cadmium, lead, nickel and zinc is common in contaminated soils.