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EFFECT OF HEAVY METALS ON SEEDLING SURVIVAL OF RAPHANUS SATIVUS VARIETY PUSA CHETKI

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ABSTRACT

The effects of heavy metals on seedling survival were investigated through pot culture experiments. The heavy metals evaluated in this study were copper, nickel, zinc, cadmium, and lead. The results revealed varying impacts on the survival of radish seedlings, depending on the specific metal and its concentration in the soil. Copper, nickel, and zinc exhibited a gradual decrease in seedling survival as their concentrations increased. At concentrations ranging from 100 to 1000 mg/kg of soil, there was 100% seedling survival for these metals. However, cadmium and lead had a much more significant detrimental effect on seedling survival. As their concentrations increased from 100 to 1000 mg/kg of soil, the seedling survival percentage decreased to 83% for both cadmium and lead. The observed reduction in seedling survival percentage of radish plants can be attributed to several factors. One possible reason is that the heavy metals present in the soil may inhibit the growth and activity of beneficial microorganisms that contribute to soil fertility. These microorganisms play essential roles in nutrient cycling and making nutrients available to plants. When their growth is inhibited, the soil fertility deteriorates, leading to adverse effects on seedling survival. Another possible reason for the decrease in seedling survival is the low uptake of mineral elements from the contaminated soil. Heavy metals can interfere with the uptake and assimilation of essential mineral elements by plants. This disruption in nutrient absorption can negatively impact plant growth and survival, ultimately reducing the seedling survival percentage observed in the study.

Keywords: *Heavy Metals, Seedling Survival, Cultivar Pusa Chetki Pot Culture Experiments, Soil Fertility.*

Introduction

The pollution of agricultural soils is a widespread and persistent issue that poses significant challenges for the future. Various sources, including domestic and industrial effluents, sewage, sludge, residues of pesticides, fertilizers, and detergents, contribute to soil contamination by multiple heavy metals. As a result, agricultural soils often exhibit elevated levels of heavy metals such as copper, zinc, nickel, lead, and cadmium.

The presence of these heavy metals in soils can have detrimental effects on crucial soil processes, such as respiration and litter decomposition rates. The impact of heavy metal contamination on plant growth varies depending on several factors, including the specific crop being cultivated, soil pH, and organic matter content. Interestingly, certain metals like nickel and zinc, which are relatively harmless to humans, can exhibit high toxicity to plants, leading to agricultural damage. Moreover, the contamination of plants by these heavy metals poses potential health risks to humans through the food chain. Therefore, observing the damage inflicted on susceptible plants due to heavy metal toxicity can serve as an indicator of environmental quality and the presence of specific metals in the surrounding environment.

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To contribute to the understanding of the potential damage caused by heavy metal contamination in agricultural settings, the objective of the present study was to assess the impact of heavy metals, including copper, cadmium, lead, nickel, and zinc, on the survival of Raphanus sativus cv Pusa chetki seedlings, a type of radish. This assessment was conducted through carefully designed pot culture experiments. Visual symptoms associated with heavy metal toxicity were meticulously documented and analysed to evaluate their effects on seedling survival.

By investigating the effects of heavy metals on seedling survival and closely observing visual symptoms, this study aims to enhance our understanding of the potential damage inflicted by heavy metal contamination in agricultural ecosystems. The findings from this research will provide valuable insights into the toxic effects of specific heavy metals on radish plants, enabling us to better gauge environmental quality in terms of heavy metal pollution. Ultimately, this knowledge can aid in developing effective strategies for mitigating heavy metal contamination in agricultural soils and safeguarding both crop productivity and human health.

Objectives

- Investigate the impact of copper, nickel, zinc, cadmium, and lead on seedling survival in pot culture experiments.
- Determine the concentration thresholds at which copper, nickel, zinc, cadmium, and lead negatively affect seedling survival.
- Compare the effects of copper, nickel, zinc, cadmium, and lead on seedling survival at concentrations ranging from 100 to 1000 mg/kg of soil.
- Assess the relationship between heavy metal concentration and seedling survival percentage for different metals.
- Examine the potential inhibitory effects of heavy metals on the growth of beneficial microorganisms in the soil.
- Evaluate the role of heavy metal concentration in the deterioration of soil fertility.
- Investigate the impact of heavy metals on the uptake of mineral elements from the soil by radish plants.
- Identify the specific mechanisms through which heavy metals influence seedling survival and soil fertility.
- Propose strategies to mitigate the negative effects of heavy metal contamination on seedling survival and soil health.

Materials and Methods

To investigate the impact of heavy metals on seedling survival, a series of pot culture experiments were conducted using the seeds of Raphanus sativus var. Pusa chetki. The experiments were carried out under natural environmental conditions to simulate real-world scenarios.

The pots used in the experiments were of a standardized size, measuring 15 × 15 inches. Each pot was filled with 10 kg of air-dried garden soil. To ensure proper drainage, each pot was equipped with a control drainage hole. In each pot, 20 seeds of Raphanus sativus variety Pusa chetki were sown at a depth of 5 cm and placed at equal distances from each other. To ensure reliable results, each treatment was replicated three times. Throughout the experiment, standard cultural practices were followed as needed.

To prevent any potential contamination and maintain uniform light conditions, the experimental pots were arranged at appropriate distances from each other. After 15 days of sowing, the pots were carefully examined to determine the seedling survival rate under the influence of heavy metals.

The study focused on five specific heavy metals: copper, cadmium, lead, nickel, and zinc. These metals were introduced into the soil in the form of their respective salts: copper sulfate, cadmium chloride, lead nitrate, nickel sulfate, and zinc chloride. Four different concentrations of heavy metals were used, namely 100, 500, 700, and 1000 mg/kg of soil. These concentrations were mixed thoroughly with the garden soil. For each concentration, three replicates were established to ensure reliable and representative data. Additionally, a set of pots without any heavy metal treatment served as the control group. Regular watering was carried out on a daily basis to maintain appropriate soil moisture levels throughout the experiment.

Results and Discussions

Table 1: Showing the effect of Heavy Metals on Seedling Survival (%) of Raphanus Sativus cv Pusa chetki

Sr. No.	Name of the Chemicals	Concentration (mg/kg soil)				
		Control	100	500	700	1000
1	Copper sulphate	100	100	100	100	100
2	Cadmium chloride	100	100	90	87	83
3	Lead nitrate	100	100	91	90	87
4	Nickel sulphate	100	100	100	100	100
5	Zinc chloride	100	100	100	100	100

Values represent the mean of three replicates.

The results obtained from the pot culture experiments revealed interesting findings regarding the effect of heavy metals on seedling survival. Under control conditions, where no heavy metals were added to the soil, a seedling survival rate of 100% was observed at concentrations of 100-1000 mg/kg for copper (Cu), nickel (Ni), and zinc (Zn). Similarly, at a concentration of 100 mg/kg for cadmium (Cd) and lead (Pb), the seedling survival rate remained at 100%. However, at higher concentrations of 500-1000 mg/kg for Cd and Pb, the percentage of seedling survival decreased to 83% and 87%, respectively, as indicated in Table 1.

Previous studies by Oberlaendet and Roth (1978) demonstrated a reduction in the uptake and distribution of potassium (K) and phosphorus (P) from the soil to the roots and shoots of young barley plants due to heavy metal toxicity, including Cu, Cd, Pb, Ni, Zn, and Hg. Additionally, Mehta et al. (1989) reported a decrease in yield caused by Cd toxicity in sorghum, and Narwal and Singh (1993) observed a similar reduction in maize.

In comparison to other heavy metals such as Pb, Zn, Cu, and Ni, it was evident that Cd had the highest toxicity towards the seedling survival of Raphanus sativus variety Pusa chetki in the pot culture experiments. Webber (1977) supported this observation, stating that cadmium, when added as a sulfate, exhibited greater toxicity to lettuce compared to zinc.

Cadmium, being a heavy metal pollutant, has been found to accumulate in various plant parts, leading to abnormalities in plants, as reported by Bingham et al. (1975), Bradshaw (1984), and Chug et al. (1992). The toxic effects of cadmium, as one of the most harmful heavy metals, have been well-documented and can have detrimental impacts on plant biology, as indicated by Yadav and Shrivastav (1997).

Overall, these findings highlight the significant toxicity of cadmium and its potential to adversely affect seedling survival in Raphanus sativus, underscoring the importance of understanding and managing heavy metal pollution in agricultural environments.

Conclusion

Based on the conducted pot culture experiments, the results revealed varying effects of heavy metals on seedling survival. Copper, nickel, and zinc demonstrated a gradual decrease in seedling survival as concentrations increased, while cadmium and lead exhibited a significant reduction in seedling survival at concentrations ranging from 100 to 1000 mg/kg of soil. Seedling survival remained at 100% for copper, zinc, and nickel at these concentrations, whereas it decreased to 83% for cadmium and lead.

The observed decrease in seedling survival percentage of radish plants can be attributed to multiple factors. Firstly, heavy metals have the potential to inhibit the growth of beneficial microorganisms in the soil, which can negatively impact soil fertility. Additionally, the low uptake of mineral elements from the soil by plants may contribute to the reduced seedling survival.

These findings emphasise the importance of understanding the impact of heavy metal contamination on seedling survival and soil health. Strategies aimed at mitigating the negative effects of heavy metals should be explored to protect seedling survival and ensure soil fertility. Further research is warranted to uncover the specific mechanisms by which heavy metals influence seedling survival and soil health, which will aid in the development of effective mitigation approaches.

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