The Impact Of Mercury On The Germination And Seedling Growth Of Arachis Hypogaea In A Pot Culture Experiment

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Abstract- Mercury is the only common metal which is liquid at ordinary temperatures and occurs in several forms, all of which can produce toxic effects in high enough doses. In the laboratory, a pot culture experiment was performed on Arachis hypogaea. L. (Groundnut) with and without mercury chloride treatment. Mercury treatment at 6, 8 and 10 mg/L influenced seed germination when compared to the control. Mercury concentrations of 4, 6, 8, and 10 mg/L influenced root and soot length as compared to the control. The greater dose of 10 mg/L had a significant (p 0.05) effect on the seedling and physiological changes. With increasing Hg concentrations, there was a significant decrease in seed germination, seedling development, root, and soot length.

Index Terms - Mercury, Pot culture, seedling, germination, etc.,

I. INTRODUCTION

Mercury (Hg) is a perilous heavy metal that, when found in aquatic ecosystems, has the potential to disturb the ecological equilibrium. It is noteworthy that mercury is the sole common metal that remains in a liquid state under normal temperatures and exists in various forms, all of which possess the ability to induce toxic effects when administered in sufficiently high quantities. The existence of heavy metals in the atmosphere, soil, and water, even in minute concentrations, can give rise to severe complications for all living organisms. It is important to note that heavy metals, when present in concentrations surpassing a certain threshold within a narrow range, transform into toxic substances [1].

Mercury (Hg) is a hazardous heavy metal element that poses a significant threat to both organisms and the environment when it contaminates aquatic environments. The accumulation of Hg in aquatic habitats is attributed to both natural and anthropogenic sources. Natural sources include geologic parent material, rock outcroppings, wind-blown dusts, volcanic eruptions, marine aerosols, and forest fires, while anthropogenic sources include mining, coal combustion, and hazardous industrial solid/liquid waste disposal. The release of Hg into ecosystems worldwide is a result of modern industrialization and urbanization. [2-4].

While it is widely acknowledged that the toxicity of mercury in plants is linked to its availability in the surrounding environment, limited research has been conducted on the effects of mercury under controlled conditions with restricted concentrations. Plants employ two primary strategies, namely accumulation and exclusion, to respond to high levels of heavy metals [5]. Heavy metals pose a significant environmental concern, and their increasing presence has become a pressing issue from ecological, evolutionary, and environmental perspectives [6]. The pollution caused by mercury has emerged as a critical global problem due to its detrimental impact on the environment [7]. In the 1950s and early 1960s, mercury was utilized in the separation of lithium isotopes to produce nuclear weapons [8].

The increasing influx of heavy metals into the human body as a result of industrial, agricultural, and domestic activities is a matter of global concern due to their well-documented negative effects on both human health and ecosystems [9]. Heavy metal contamination has been observed in various locations worldwide, impacting the biosphere [10-12]. The accumulation of trace metals, particularly heavy metals, in the soil has the potential to hinder the soil's functionality, cause toxicity to plants, and contaminate the food chain [15]. The presence of heavy metals can lead to a significant ecological crisis, as they are non-degradable and tend to accumulate in plant parts, resulting in a detrimental biological impact that is magnified through trophic levels. For instance, mercury has been found to reduce the levels of potassium, manganese, and magnesium in roots, while accumulating iron in root tips [16]. It is worth noting that the effects of metals are typically studied under sterile and simplified laboratory conditions, which may differ to varying degrees from real-world field conditions [17]. Plant-based bioassays offer a cost-effective and appealing approach to assess the impacts and hazards associated with various contaminants or environmental factors [18]. Moreover, they can provide valuable guidance for biomonitoring and bioremediation efforts [19, 20]. These procedures rely on the unique ability of plants to accumulate specific substances [21]. Recently, there has been a growing interest in utilizing duckweed for biomonitoring and bioremediation purposes. Duckweeds belong to the Lemnaceae family and are a type of free-floating aquatic plant. They can be found in diverse freshwater habitats, including ponds, lakes, ditches, and rice paddies [22]. Additionally, several studies have investigated the effects of mercury on seed germination [23, 24].

II. METHODOLOGY

Seeds of Arachis hypogaea L. were obtained in a random manner from Dr. A. G. Ranga Agricultural University in Tirupati, Andhra Pradesh, India. To remove any contaminants from the seed coat, the seeds were subjected to a treatment of 0.1N Mercuric chloride for a duration of two minutes, followed by five washes with running tap water. This experiment was carried out on Arachis hypogaea L. using different concentrations of Mercuric chloride (2, 4, 6, 8, and 10 mg/L), with distilled water serving as the control. Twenty-five seeds were placed in petri dishes, and daily 10 ml of $Hgcl_2$ solution was added. Each day, twenty-five seeds were planted in petri dishes on Whatman paper No.42, along with 5 ml of the heavy metal $Hgcl_2$ solution. The investigation was conducted in a laboratory setting, both during the day and at night, to assess the root, shoot length, and seedling growth of Arachis hypogaea L. through a pot culture experiment. After a period of 5 days of incubation, the number of seed germinations was recorded and expressed as a percentage of germination. Following 21 days of seedling growth, the length of the roots and branches was measured using a meter scale.

III. RESULTS

Table 1 presents the data on the seed germination, seedling, root, and shoot lengths of groundnut. The application of mercuric chloride solution (2, 4, 6, 8, and 10 mg/L) resulted in a reduction in the parameters of groundnut as compared to the control. Notably, the mercury treatment at concentrations of 6 mg/L, 8 mg/L, and 10 mg/L exhibited a significant impact on seed germination. Furthermore, a 10 mg/L increase in mercury chloride content had a substantial effect on the growth of groundnut seedlings in comparison to the control. However, an increase in the concentration of mercuric chloride up to 6 mg/L had detrimental effects on root growth and shoot length.

Treatment Mercury chloride (Hg) mg/ L	**Seed germination (%)**	**Root Length (cm)**	**Shoot Length (cm)**	**Seedling Length (cm)**
Control	92 ± 0.282	6.3 ± 1.042	10 ± 1.084	12 ± 0.186
2mg/ L	84 ± 0.523	4.6 ± 0.114	8.0 ± 0.357	11.8 ± 0.707
4 mg/ L	63 ± 0. 298	2.8 ± 0.136	7.5 ± 0.132	11 ± 0.707
6mg/ L	46 ± 0.075	2.5 ± 0.135	7.3 ± 0.217	5.9 ± 0.434
8 mg/ L	32 ± 0.074	2.0 ± 0.286	6.0 ± 0.244	5.5 ± 0.189
10 mg/ L	24 ±0.220	1.8 ± 0.162	5.0 ± 0.242	5.1 ± 0.296

Values are arithmetic mean ± S. E. of three replicates.

Table 1. Effect of different concentration of $Hgcl_2$ on seed germination, root, shoot and seedling length of Arachis hypogeae *L*.

Number Followed by the same letter in the same column are not significantly different at P< 0.005.

IV. DISCUSSION

Arachis hypogaea L, a member of the Fabaceae family, is a valuable cash crop and rotation crop. The byproducts of groundnut, including shell, haulms, and hay, are excellent sources of fodder. Ground nut cake is a nutritious feed for cattle and can also be used as manure after oil extraction. Its high dietary fiber content makes it an ideal food for digestion. Trees and plants can absorb metals directly or indirectly through water and soil contamination. Mercury is harmful to human health, as well as bacteria, plants, and animals. The concentration of mercury in seed germination and seedling of Arachis hypogaea L. gradually decreased. Mercury treatment significantly reduced seed germination when compared to the control. However, shoot length and root growth of Arachis hypogaea L increased with increasing mercury concentrations when compared to the control. Finally, it was discovered that mercury chloride posed a significant hazard to the seedling growth of Arachis hypogaea L.

V. CONCLUSION

The findings of this study regarding the impact of mercuric chloride on Arachis hypogaea L highlight the necessity for further investigation into mercury contamination in plants via soil. This research holds significant importance in elucidating the effects of mercuric pollution on plants through soil, as it enables the exploration of plant physiology through the utilization of diverse metal concentrations. Moreover, additional research is imperative to comprehensively analyze metal determination in the environment and various plant regions.

VI. REFERENCES

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