Germination and Seedling Growth Responses of *Ipomea aquatica* at Varying Concentrations of Co^{2+} and Cu^{2+}

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Abstract

Aquatic macrophytes are known to accumulate heavy metals in varying concentrations. Only a little information is available on the effects of heavy metals on seed germination and seedling growth of plants that are used both for human consumption and phytoremediation, thus the present study was aimed at assessing the effects of different concentrations of Co^{+2} and Cu^{+2} on germination and seedling growth of *Ipomea aquatica.* Five different concentrations (0, 0.1, 0.01, 0.001 and 0.0001mol dm^{-3}) of Co and Cu were used in treating seeds which were then placed on plastic pots containing coir dust and sand media. The germination trial was arranged according to CRD with five replicates each with 25 seeds. The number of seeds germinated in each pot was counted daily for two weeks and the germination percentage was calculated. Seedlings were allowed to grow for further14 days and root and shoot length of seedlings, seedling vigor index in various metal concentrations were measured. Seed germination was found to be not affected by Cu^{+2} up to 0.001mol dm^{-3}. However, no seed was found to be germinated at 0.1 mol dm^{-3} of Cu^{+2}. In the case of Co^{+2}, seeds were successfully germinated even at the concentration of 0.01mol dm^{-3}. Resultsrevealed that Co^{+2} could enhance the vigor and growth of the seedlings up to 0.0001mol dm^{-3}, though higher concentrations resulted in growth reductions. In contrast, Cu^{+2} even at the lowest concentration (0.0001mol dm^{-3}), decreased the growth and vigor implying that the species is more sensitive to Cu^{+2} than Co^{+2}.

Key words: *Ipomea aquatica,* heavy metals, seed germination, growth

Introduction

In addition to the steady export market, the local demand for leafy vegetables is also rising, mainly among people in the urban areas. Cultivation of leafy vegetables is thus becoming commercialized in Sri Lanka. Among commercially cultivated leafy vegetables, Kankung (*Ipomea aquatica)* is considered to be one of the highly demanded candidates irrespectively the age or social status of the consumer. Unproductive paddy fields are easily utilized for cultivation of Kangkung. It is done commercially in the districts of Gampaha, Colombo, Kalutara, Galle, and Matara while there is a potential to increase.

Heavy metal contamination from different sources is of priority concern owing to their potential risk in damaging crops or the ecosystem; through related products, they may pose serious risks to humans as well. Heavy metals can accumulate in plants through both foliage and root systems. Though many heavy metals are essential as important constituents of pigments and enzymes (mainly zinc, nickel, and copper), some metals, especially cadmium, lead, mercury, and copper, are toxic in high concentrations because they disrupt enzyme functions, replacing essential metals in pigments or producing reactive oxygen species. Due to the large surface area exposed to the environment, leafy vegetables can accumulate much higher content of heavy metals compared to other kinds of vegetables thus can be used for phytoremediation as well. However, only a little

information is available on the effects of heavy metals on seed germination and seedling growth of leafy vegetables that are used both for human consumption and phytoremediation.

The overall objective of the present study was to assess the effects of different concentrations of Cu^{+2} and Co^{+2} on germination and seedling growth of *Ipomea aquatica*.

Materials and Methods

Sterilized and vacuum packed seeds of *Ipomea aquatica* (variety Thai) were obtained from a local market and used for the germination trial. Different concentrations (0, 0.1, 0.01, 0.001, and 0.0001mol dm^{-3}) of metal (Cu^{+2} and Co^{+2}) solutions were made by appropriate dilution of the stock solutions initially prepared and kept in the refrigerator until use. Germination trial was conducted in plastic pots. Quarter of the pots was filled with coir dust and rest of the volume was filled with sand. Twenty five seeds were placed in each plastic pot (about 2cm depth). The pots were irrigated with 25 ml of the metal solutions and distilled water once a day.

The number of seeds germinated in each pot was counted daily for two weeks and the germination percentage was calculated. Seedlings were allowed to grow for further 14 days. The root and shoot length of seedlings, seedling vigor index in various metal concentrations were measured. Completely randomized design was used with five replicates. The data were statistically analyzed by Analysis of Variance (ANOVA) to determine the level of significance at $P < 0.05$.

Results and Disscussion

Effect of Cu^{+2}

According to the results, germination of *Ipomea aquatica* seeds followed a dose-dependent pattern, where the highest seed germination (55.2 %) was recorded from the seeds treated with 0.001mol dm^{-3} of Cu^{+2} while at 0.1mol dm^{-3} no seeds were germinated (Figure 1). The growth of *Ipomea aquatica* seedlings was found to be significantly affected by higher concentrations of Cu^{+2} though at lower concentrations, the metal could promote the root as well as shoot growth compared to the control. Among the treatments, the highest shoot length (15.08 cm) was recorded at 0.0001mol dm^{-3} followed by 14.99 cm at 0.001mol dm^{-3} of Cu^{+2}. Apart from the highest concentration (0.1 mol dm^{-3}), no significant differences in vigor index could be observed among the other treatments.

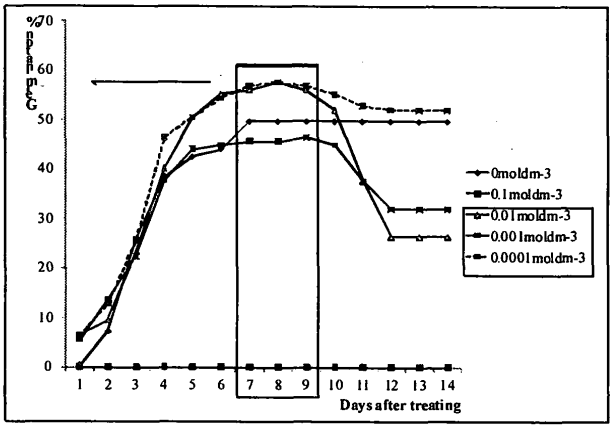

Figure2. Impact of different concentrations of Co^{+2} on seed germination of *Ipomea aquatica*

The present study investigated the germination and seedling growth of *Ipomea aquatica* under different concentrations of Copper and Cobalt. Our results are in consistent with Sun and Wu (1998) who also have studied the effect of metals on *Ipomea aquatica*. According to them, the toxicity threshold concentrations for Ni, Cu, Zn, Cr, Cd, Mn, As, and Al are 2.5, 5, 5, 1.25, 1, 20, 2, and 50 ppm, respectively. As reported by Rose *et al.* (2011), the seed germination of the spinach was affected by the 0.01 to 0.001 mol/l concentrations of Pb.

Conclusion

The maximum tolerable limit for seed germination of *Ipomea aquatica* is 0.001mol dm^{-3} and 0.01mol dm^{-3}, respectively for $Cu^{+2}$and Co^{+2}. The seedlings growth and vigor could be enhanced by Co^{+2} up to 0.0001mol dm^{-3}, though higher concentrations resulted in growth reductions. In contrast, Cu^{+2}even at the lowest concentration (0.0001mol dm^{-3}), decreased the growth and vigor implying that the species is more sensitive to Cu^{+2}than Co^{+2}.

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