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Detrimental Effects of Selected Salts on Seed Germination and Growth Parameters of Spinach (Spinacia oleracea)

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ABSTRACT

The major problem in peri urban areas is the poor quality of irrigation water since the waste from all sources is disposed in the rivers and other water bodies. This result in accumulation of heavy metals like Zinc Sulphate (ZnSO4), Cadmium Sulphate (CdSO4) and Copper Sulphate (CuSO4) in the water source has adverse effect on seed germination, Plant growth, and human health. With above reference an experiment was conducted to study the effect of different concentration (0, 10, 20, and 30 ppm) of Zinc Sulphate (ZnSO4), Cadmium Sulphate (CdSO4) and Copper Sulphate (CuSO4) in spinach (Cv. Pusa All green). The seed were soaked in each concentration of chemical for 72 hours. Data was collected on seedling germination percentage, seedling length, seedling fresh weight, seedling dry weight of Spinach. Results showed that seedling germination percentage, seedling length, seedling fresh weight, seedling dry weight is decreased in different concentration Zinc Sulphate (ZnSO4), Cadmium Sulphate (CdSO4) and Copper Sulphate (CuSO4) as compared to the control. Therefore, it can be inferred from the study that salt affected irrigation water has negative effect on germination percentage, seedling length, seedling fresh weight, seedling dry weight which may otherwise influences the yield and farm level profitability of vegetable production.

Keywords
Seed, Heavy metals, Water, Spinach.

Introduction

Heavy metals with high concentration inhibited seed germination, growth and development of Plant and also disturb the many biochemical and physiological process which causes strongly reduce/negative effects on plant growth and their development (Kabata and Pendias, 2001). Many studies on the plants growing on metal-contaminated sites are mainly focused on the metal effects on the plant seed germination. Pollutions of agricultural land by heavy metals are on the increase. Some environmentalists earlier identified various sources of such pollutions in the natural terrestrial ecosystem to include air born metal from automobile exhaust fumes, paint and battery and other industrial activities (Chisolm, 1971; Singh et al., Odoemena and Akpabio, 1997). The consequences of accumulation of such metals include reduction in the metabolic activity of many soil microorganism with a subsequent decrease in the soil CO2 evolution (Caxufield, 1961) as well as leaf necrosis in and chlorosis of higher plant (Bernstein, 1961; Trubyand Raba, 1990). Heavy metal include about thirty eight elements some of them are even
necessary for the growth of higher plants. However that act toxically at high concentration since they have a strong affinity for numerous organic compounds the response of plant growth of higher plant and metabolism to heavy metals has become a subject of great interest in recent years because of their toxicity to plants heavy metal contamination of soil is a worldwide problem of increasing importance and great environmental concern. The problem of environmental pollution on account of essential industrial growth is practical terms the problem of disposal of industrial water whether solid, liquid are gaseous. All three type of wastes have the potentially of ultimately polluting water. Polluted water in addition to other effects of soil not only in industrial areas but also in agricultural fields, as well as the beds of rivers, creating secondary sources of pollution. Use of industrial effluent and sewage sludge on agricultural land has become a common practices in India. As a result of which these toxic metal can be transferred and concentrated into plant and themselves may become a health hazard to man and animals. Above to certain and over a narrow range, the heavy metals turn in to toxins. Cadmium metals are considered the most important source of environmental pollution that is deposited from natural and human activity (Gaur and Adholeya, 2004). Cadmium (Cd), copper (Cu) and zinc (Zn) are examples of metals that are found naturally in low quantities. Zn and Cu are micronutrients of growth medium that are needed by plants for growth and various biochemical and physiological pathways (Narula et al., 2005). High levels of these elements are toxic to sensitive plants (Das et al., 1997). Metal concentration toxicity leads to chlorosis, necrosis and root system damage (Atanassova and Zapryanova, 2009), photosynthesis inhibition, plasma membrane permeability damage (Narula et al., 2005). Cadmium is a non-essential element; it is considered a significant soil pollutant because of its toxicity and greater solubility in water (Das et al., 1997; Jain et al., 2007). The main sources of Cd are mining, phosphate fertilizers, pesticides and industrial waste. Cd affects nitrogen metabolism, membrane function and chlorophyll biosynthesis (Jain et al., 2007). Therefore present investigation was undertaken to study the use of waste water with pure/treated water for irrigating vegetable crops and their effect on soil and crops.

Materials and Methods

An Experimental trial on spinach (var. Pusa All green) was conducted in ZnSO₄, CuSO₄ and CdSO₄ at concentration of 10 ppm, 20 ppm and 30ppm for each with control for preparation of solution of salts viz. ZnSO₄, CuSO₄ and CdSO₄, 12.5mg, 25mg and 37.5mg of each salts are dissolved in 450ml distilled water for 10ppm, 20ppm and 30ppm respectively (Table 1).

20 seeds are taken for each test and seeds are soaked in particular concentration i.e., 10ppm/20ppm/30ppm of ZnSO₄, CuSO₄ and CdSO₄ solution for 24 hours. The seeds are kept in sterilized petri plates the moist blotting paper 20 seeds are taken in petri plates as control for each salts experiment. Observation was made on seed germination, seed length, seedling fresh weight and seedling dry weight in different concentration of salts.

Results and Discussion

Effect of heavy metals on seed germination

The seeds appear to be designed to closely monitor environmental condition; germination inhibition appears take the first defense mechanism that seeds exhibits when
environmental condition are adverse Li et al., 2005. In spinach all green germination is decreased as ZnSO₄ concentration is increased. In 10 ppm germination is 90% in 20 ppm 80% and in 60% as compared to 100% in control. Here germination percent is inversely proportional to salt concentration. In CuSO₄ solution, germination is decreased in different concentration as compared to control. In 10 ppm, 20 ppm, 30 ppm of CuSO₄ solution the germination percent is 80%, 70%, and 60% in comparison to control 100%. But in comparison to ZnSO₄ the germination is low at 10 ppm and 20 ppm of CuSO₄ solution. In ZnSO₄ at this concentration germination percentage are 90% and 80% where as in CuSO₄ these are 80% and 70% respectively but at 30 ppm in both salt solution germination is 60%. Germination percentage is also decreased in different concentration of CdSO₄ solution comparison to control. At 10 ppm, 20 ppm and 30 ppm of CuSO₄ the germination percentage is 80%, 70%, and 50% respectively in comparison to 100% in control. But at 30 ppm CdSO₄, germination percentage is 50% in Comparison to 60% in ZnSO₄ and CuSO₄ solution. Maximum seed germination percentage was recorded on control and 10 ppm of zinc concentration while the minimum germination percentage (50%) were found at 30 ppm of CdSO₄. These results are in agreement with the finding of Burhan et al., 2001 (Table 2).

**Effect of heavy metals on seedling length**

Seedling length is also decreased as in ZnSO₄ concentration is increased in comparison to control seedling length is 8.03 mm, 6.89 mm and 5.89 mm in 10 ppm, 20 ppm and 30 ppm respectively in comparison to 10 mm in control. Seedling length is decreased as the CuSO₄ solution concentration is increased at 10 ppm, 20 ppm, 30 ppm the seedling length are 4.73 mm and 4.43 mm and 3.36 mm to 10 mm in control. Decrease in seedling length is more in CuSO₄ solution than ZnSO₄. Seedling length is also decreased as CdSO₄ solution concentration is increased. At 10 ppm, 20 ppm and 30 ppm the seedling length 4.70 mm, 4.41 mm in ZnSO₄ mm and 3.30 mm in comparison to 10 mm in control. Decreasing in seedling length is almost similar to CuSO₄ but decrease is more than ZnSO₄ solution where at 10 ppm, 20 ppm and 30 ppm the seedling lengths are 8.03 mm, 6.89 mm and 5.89 mm respectively.

**Table 1 Preparation of salts**

|                | ZnSO₄ | CuSO₄ | CdSO₄ |
|----------------|-------|-------|-------|
| **Concentration** | 10 ppm | 10 ppm | 10 ppm |
| **Quantity of salts** | 12.5 mg | 12.5 mg | 12.5 mg |
| **Quantity of water** | 480 ml | 480 ml | 480 ml |

|                | ZnSO₄ | CuSO₄ | CdSO₄ |
|----------------|-------|-------|-------|
| **Parameters** | Germination | Seedling length (mm) | Seedling fresh weight (gm) | Seedling dry weight (gm) |
| **Spinach** | 90% | 80% | 60% | 100% | 80% | 70% | 60% | 100% | 80% | 70% | 50% | 100% |
| Germination | 10 ppm | 20 ppm | 30 ppm | Control | 10 ppm | 20 ppm | 30 ppm | Control | 10 ppm | 20 ppm | 30 ppm | Control |
| Seedling length (mm) | 8.03 | 6.89 | 5.89 | 10 | 4.73 | 4.43 | 3.36 | 10 | 4.70 | 4.41 | 3.30 | 10 |
| Seedling fresh weight (gm) | 0.09 | 0.07 | 0.06 | 0.15 | 0.08 | 0.06 | 0.05 | 0.15 | 0.06 | 0.04 | 0.03 | 0.15 |
| Seedling dry weight (gm) | 0.095 | 0.074 | 0.050 | 0.135 | 0.080 | 0.035 | 0.030 | 0.135 | 0.040 | 0.030 | 0.020 | 0.135 |
The reduction in seedling length of the seeds to varying metal treatments could have been brought about by the reduction of mitotic cell in the plant meristematic zone. Muhammad 2008.

**Effect of heavy metals on seedling fresh weight**

Seedling fresh weight is also decreased as ZnSO$_4$ concentration is increased. In control seedling fresh weight is 0.15 mg where as in 10ppm, 20ppm, 30ppm the weight is 0.09mg, 0.07mg, 0.06mg respectively. Seedling fresh weight in CuSO$_4$ solution of 10ppm, 20ppm 30ppm are 0.08mg, 0.06mg, 0.05mg, respectively. Here in both the solution viz., ZnSO$_4$ and CuSO$_4$ the Seedling fresh weight are almost similar. Seedling fresh weight decreases with increasing concentration of CdSO$_4$. At 10ppm, 20ppm and 30ppm of CdSO$_4$ solution the seedling fresh weight is 0.06mg, 0.04mg 0.03, mg respectively in comparison to 0.15 mg. in control. Seedling fresh weight decreased more in CdSO$_4$, than ZnSO$_4$ and CuSO$_4$ solution.

**Effect of heavy metals on seedling dry weight**

Seedling dry weight is also decreased as ZnSO$_4$ concentration is increased In comparison to control. In Dry weight is 0.135 mg where as in 10ppm, 20ppm, and 30ppm where as in 10ppm, 20ppm, 30ppm seed ling dry weight is 0.095mg, 0.074mg and 0.050 mg respectively. Seedling dry weight also decreased at 10ppm, 20ppm and 30ppm of CuSO$_4$ solution, viz., 0.080mg, 0.035mg, 0.030mg respectively in comparison to 0.135mg in control. Here decreases in dry weight are more than ZnSO$_4$. Seedling dry weight is also decreased in CdSO$_4$ solution at different concentration. At 10ppm, 20ppm and 30ppm the dry weight are 0.040mg, 0.030mg, 0.020mg respectively than 0.135mg in control dry weight is decreased more than ZnSO$_4$ and CuSO$_4$. The characteristic feature of toxicities in plant due to heavy metal chlorosis and reduction in net photosynthetic which leads to decrease plant growth and productivity (Sweta, 2006)

It is concluded that Spinach (All Green) variety which can be cultivated at those areas at which heavy metals are present in soil or in the water used for irrigation as they showed some resistance against heavy metals treatment, which is proved by their data in germination %, seedling length, seedling fresh and seed ling dry weight parameters.

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