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

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A B S T R A C T

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 ($ZnSO_4$), Cadmium Sulphate ($CdSO_4$) and Copper Sulphate ($CuSO_4$) 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 ($ZnSO_4$), Cadmium Sulphate ($CdSO_4$) and Copper Sulphate ($CuSO_4$) 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 ($ZnSO_4$), Cadmium Sulphate ($CdSO_4$) and Copper Sulphate ($CuSO_4$) 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.

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 CO_2 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 $ZnSO_4$, $CuSO_4$ and $CdSO_4$ at concentration of 10 ppm, 20 ppm and 30ppm for each with control for preparation of solution of salts viz. $ZnSO_4$ $CuSO_4$ and $CdSO_4$, 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 $ZnSO_4$, $CuSO_4$ and $CdSO_4$ 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 seed ling 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 $ZnSO_4$ concentration is increased. In 10 ppm germination is 90% in 20ppm 80% and in 60% as compared to 100 % in control. Here germination percent is inversely proportional to salt concentration. In $CuSO_4$ solution, germination is decreased in different concentration as compared to control. In 10ppm, 20ppm, 30ppm of $CuSO_4$ solution the germination percent is 80%, 70%, and 60% in comparison to control 100%. But in comparison to $ZnSO_4$ the germination is low at 10ppm and 20ppm of $CuSO_4$ solution. In $ZnSO_4$ at this concentration germination percentage are 90% and 80% where as in $CuSO_4$ these are 80% and 70% respectively but at 30ppm in both salt solution germination is 60%.Germination percentage is also decreased in different concentration of $CdSO_4$ solution comparison to control. At 10ppm, 20ppm and 30ppm of $CuSO_4$ the germination percentage is 80%, 70%, and 50% respectively in comparison to100% in control. But at 30ppm$CdSO_4$, germination percentage is 50% in Comparison to 60% in $ZnSO_4$ and $CuSO_4$ solution. Maximum seed germination percentage was recorded on control and 10ppm of zinc concentration while the minimum germination percentage (50%) were found at 30 ppm of $CdSO_4$. 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 $ZnSO_4$ concentration is increased in comparison to control seedling length is 8.03 mm, 6.89mm and 5.89mm in 10 ppm,20ppm and 30ppmrespectively in comparison to 10mm in control. Seedling length is decreased as the $CuSO_4$ solution concentration is increased at 10ppm, 20ppm, 30ppm the seedling length are 4.73mm and 4.43mmand 3.36 mm to 10mm in control. Decrease in seedling length is more in $CuSO_4$ solution than $ZnSO_4$. Seedling length is also decreased as $CdSO_4$ solution concentration is increased. At 10ppm,20ppm and 30ppm the seedling length 4.70mm, 4.41mm in $ZnSO_4$ mm and 3.30mm in comparison to 10mm in control. Decreasing in seedling length is almost similar to $CuSO_4$ but decrease is more than $ZnSO_4$ solution where at 10ppm, 20ppm and 30ppm the seedling lengths are 8.03mm, 6.89mm and 5.89mm respectively.

Table.1 Preparation of salts

	$ZnSO_4$			$CuSO_4$			$CdSO_4$		
Concentration	10ppm	20ppm	30ppm	10ppm	20ppm	30ppm	10ppm	20ppm	30ppm
Quantity of salts	12.5mg	25mg	37.5mg	12.5mg	25mg	37.5mg	12.5mg	25mg	37.5mg
Quantity of water	480ml	480ml	480ml	480ml	480ml	480ml	480ml	480ml	480ml

Table.2 Effect of heavy metals on seed germination

Crops		$ZnSO_4$				$CuSO_4$				$CdSO_4$			
	Parameters	10 ppm	20 ppm	30 ppm	Control	10 ppm	20 ppm	30 ppm	Control	10 ppm	20 ppm	30 ppm	Control
Spinach	Germination	90%	80%	60%	100%	80%	70%	60%	100%	80%	70%	50%	100%
	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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