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To Assess the Toxicity of Nickel on Above and Below Ground Biomass of Raphanus Sativus Variety Pusa Chetki in Natural Conditions (Pot Culture Experiments)

Dr. Rajshree Gupta

Professor, Botany, B. B. D. Govt. College, Chimanpura, Shahpura, Jaipur, Rajasthan, India
Email: *rajshreegupta[at]rocketmail.com*

Abstract: ***A heavy metal has a density of five or more. Many reports on nickel as a heavy metal pollutant are available. Heavy metal accumulation in the soil inhibits root growth, inactivating soil enzymes and eliminating soil microorganisms. The toxicity of heavy metals to plants depends on the physico - chemical properties of the recipient environment. The information on the effect of heavy metal nickel on radish in pot culture is limited. Therefore experiments were conducted in pots to find out. The impact of heavy metal nickel on above and below ground biomass of Raphanus sativus variety Pusa chetki. Radish is grown practically all year round but radish grown in hot season is rather pungent. Closer examination of the figures for above ground biomass and below ground biomass of Raphanus sativus variety pusa chetki revealed that it decreased with the increasing concentration of heavy metal nickel. This might be associated with the reason that higher levels of heavy metal nickel decrease the number of cells and suppress the elongation of developing root and shoot which in turn retarded the growth.***

Keywords: Raphanus sativus, variety Pusa chetki, Pot culture experiments, heavy metal nickel, above and below ground biomass.

1. Introduction

The accumulation of toxic metals in crops is receiving a great deal of attention. Heavy metals are hazardous pollutants as they are toxic, often accumulated and even biomagnified by plant parts including seeds and have deleterious biological effects. The toxicity of heavy metals to plants and animals depends on chemical properties of the recipient environment.

The information on the effects of heavy metal nickel on crops in pot culture is limited. Therefore experiments were conducted in pots to examine the effect of heavy metal nickel on above and below ground biomass of radish (Raphanus sativus) variety pusa chetki.

Radish is perhaps the most quickly and easily grown vegetable of the kitchen garden and is ready for use in 3 to 6 weeks from the time of sowing. Many varieties of radish are in cultivation differing greatly in size, shape and colour of the roots.

The objective of the present investigation was to assess the toxicity of nickel on above and below ground biomass of radish plants (Raphanus sativus L.).

The damage caused by heavy metals, is proper to say is a damage caused both by water pollution and soil pollution. Soil pollution through contamination of soil in cultivated fields by industrial effluents loaded with heavy quantities of toxic metal is emerging as a new threat to agriculture.

Heavy metals are hazardous pollutants as they are toxic, often accumulated and even biomagnified by plant parts, including seeds and have deleterious biological effects.

Many reports on nickel as a heavy metal pollutant are available [4].

2. Material and Methods

Raphanus sativus variety Pusa chetki has comparatively long period of growth. It is an early maturing variety of 40 - 45 days and popular in the city for its mild pungency. Its roots are medium in size, i. e.15 - 22 cm long and 12.5 to 13.0 cm in diameter. It is suitable to grow in hotter months, i. e. mid-April to mid-September when other varieties cannot be grown.

Twenty seeds of Raphanus sativus cv. Pusa chetki were sown in pots filled with 10 kg air dried garden soil.

Heavy metal nickel was added to the soil in the form of its salt viz., nickel sulphate. The soil was treated and mixed with four concentrations, namely, 100, 500, 700 and 1000mg/kg of heavy metal nickel. A set of pots without heavy metal treatment served as control. Watering was done daily.

Each treatment was replicated thrice. Plants were raised under natural environmental conditions. The size of pots was 15×15 inches. A control drainage hole was present in each pot. Seeds were sown at 5 cm depth at equal distances in the prepared pots. Normal culture practices were performed regularly.

Ten days after sowing, the pots were examined for seed germination. Then after 15 days of growth, observing the seedling survival, four plants were retained in each pot. After 45 days of growth, above and below ground biomass were recorded.

3. Result and Discussion

Growth inhibition by nickel has been reported in tomato, oat, rice, corn, bean, soyabean and sunflowers. Higher concentrations of nickel besides suppressing activity of various enzymes and protein synthesis also cause ion competition antagonism and/or synergism in the culture medium [8].

Though at low concentrations nickel stimulates some physiological processes yet at higher concentrations it causes abnormalities including severe chlorosis and necrosis and an overall retardation of growth in certain plants as reviewed [3].

Wheat (Triticum aestivum L. cv. VVL 711) plants grown in nutrient medium containing toxic concentrations of NiCl2 (300, 400 and 500 microgram per ml) exhibited growth with a decrease in internode length and their fresh and dry weights. Analytical studies showed inhibition of lignifications and/or wall thickening of hypodermal cells, suppression of vascular tissue differentiation and decrease in the number of cell layers [6].

Table 1: Shows the data regarding the effect of heavy metal nickel's different concentrations on above and below ground biomass of Raphanus sativus variety Pusa chetki in pot culture experiments

S. No	Name of the Chemical	Concentrations (mg/kg soil)									
		Control		100		500		700		1000	
		A. G. B	B. G. B	A. G. B	B. G. B.	A. G. B	B. G. B	A. G. B	B. G. B	A. G. B	B. G. B
1	Nickel sulphate	190	195	170	185	150	170	120	170	105	120

(Values represent the mean of three replicates)

Analysis of variance:

F - ratios for seed germination:

	A. G. B.	B. G. B.
Control Vs Treatment	150.6946***	46.1661***
Among concentrations	37.2920***	13.1627***

*** = highly significant
A. G. B = Above ground biomass
B. G. B. = Below ground biomass

Closer examination of the figures (table 1) for above ground biomass and below ground biomass of Raphanus sativus variety pusa chetki revealed that it decreased with the increasing concentration of heavy metal nickel. This might be associated with the reason that higher levels of heavy metal nickel decrease the number of cells and suppress the elongation of developing root and shoot which in turn retarded the growth or this may be the result of inhibition of wall thickening of cells of root and shoot due to heavy metal toxicity, resulting in decreased values of above and below ground biomass.

Earlier also several workers have observed the reduction in seedling fresh weight due to heavy metals. Reduction in fresh weight of pigeon pea may be due to high amount of heavy metals which damage the plant cells so that plant cannot grow in high concentrations [7]. Similar type of observations for inhibition in seedling fresh weight were also reported in soyabean [1].

Reduction in seedling fresh weight due to heavy metals toxicity has also been observed in chickpea [2] and groundnut, seasame and sunflower [5].

At higher concentration (8.52× 10 - ⁴M) of nickel, all the three cultivars cv. Arkel, cv. Bonneville and cv. T - 163 of Pisum sativum exhibited decreased seedling fresh weight [9].

In present investigation I found that application of heavy metal nickel decreased the biomass (fresh) of radish (Raphanus sativus) variety pusa chetki. Even at 100 mg per kilogram concentration, nickel reduced the above (170 gram per plant) and below ground biomass (185 g/plant) in comparison to the control in which the above and below ground biomass was 190 g/plant and 195 g/plant, respectively. At 500 and 700 mg per kilogram concentrations of nickel, the value for below ground biomass was similar that is 170 gram per plant but at 100 milligram per kilogram concentration it decreased significantly to 120 gram per plant. It was also observed that 700 and 1000 mg/kg concentration of Ni in the soil, was most toxic to below ground biomass of Raphanus sativus variety Pusa chetki. But for above ground biomass all the concentrations of Ni were found to be toxic. Statistical analysis also showed that there were highly significant differences between control and treatments and also among various treatments of nickel themselves for both the above and below ground biomass.

4. Conclusion

Closer examination of data showed that the above and below ground biomass of 45 days old plants of Raphanus sativus cv. pusa chetki decreased significantly with increasing concentrations of heavy metal nickel.

The above and below ground biomass decreased to 55% and 61% in comparison to control. It may be assumed that poor plant growth due to heavy metal toxicity resulted in a lower biomass of radish plants. The reduction in growth and biomass of radish plants may be attributed with the fact that heavy metal nickel might inhibit the growth of beneficial microorganisms of soil which may deteriorate the soil fertility or due to the low uptake of mineral elements from soil.

These results can be only as an indicator guide to the relative sensitivity of radish crop to the metal and to the range of metal application which can affect yield according to season and soil. The form in which the metal is present, rooting volume and the growing environment are all factors which can affect the metal toxicity to the crop. The study suggests that cultivation of the crop in polluted soil should be avoided or appropriate control measures be adopted to regulate the heavy metal content of soil.

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