Biosc.Biotech.Res.Comm. Special Issue Vol 13 No 12 (2020) Pp-143-146

BBRC
Bioscience Biotechnology Research Communications

Effect of Nickel on Germination, Seedling Growth And Biochemical Alterations of *Sesamum orientale* L.

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ABSTRACT

Environmental pollution by toxic metal has accelerated dramatically since the beginning of the industrial revolution. The primary source of this pollution include the burning of fossils, mining and smelting of metaliferous ores, municipal waste, fertilizers, pesticide and sewage. Toxic metal contamination of ground water and soil, which poses major environmental and human health problems, is currently in need of an effective and affordable technological solution. In this study, germination was conducted in Til (*Sesamum orientale* L.) in order to find out the effect of Ni toxicity on its germination, growth and biochemical parameters. The seeds were germinated in six different concentrations of nickel chlorode solution having 0-50 mg/l of nickel. The pot culture experiment was done with different concentrations (10, 20, 30, 40 and 50 ppm) of nickel. It was noted that the Seedling vigour index, Metal tolerance index were found to be reduced and the percentage of phytotoxicity was increased and biochemical parameters showed a declining trend with increasing Ni concentrations. The seedlings treated with Ni showed decreased chlorophyll and soluble protein content as compared to control while increased proline content was observed as compared to control.

KEY WORDS: NICKEL, GERMINATION, BIOCHEMICAL CHANGES, PHYTOTOXICITY, SEEDLING VIGOUR INDEX.

INTRODUCTION

Heavy metals are significant environmental pollutants, and their toxicity is a problem of increasing significance for ecological, evolutionary, nutritional and environmental reasons. The term ''heavy metals'' refers to any metallic element that has a relatively high density and is toxic or poisonous even at low concentration. There are 35 metals that concern us because of occupational and residential exposure, out of which 23 are the heavy elements or "heavy metals". Heavy metal can include elements lighter than carbon and can include some of the heaviest metals [1]. Metals such as aluminium, arsenic, cadmium, cobalt, chromium, copper, lead, manganese, mercury, nickel, selenium and zinc have been considered as the major environmental pollutants and their phytotoxicity has been established [2, 3, 4, 5].

It has been reported that metals such as cobalt, copper, chromium, iron, magnesium, manganese, molybdenum, nickel, selenium and zinc are essential nutrients that are required for various biochemical and physiological functions. Inadequate supply of these micronutrients results in a variety of deficiency diseases or syndromes. Elevated concentrations of both essential and nonessential heavy metals in soil and water can lead to toxicity symptoms and growth inhibition in most plants [6, 7, 8]. Absorption, translocation and accumulation of heavy metal ions of Hg, Pb, Cr and Cd by plants, reduce qualitative and quantitative productivity of the species and cause serious health hazards through the food chain to other life forms [9, 10, 11, 12, 13, 14, 15]. Different heavy metals at supra-optimal concentrations have been shown to inhibit various metabolic process in plants

ARTICLE INFORMATION

*Corresponding Author: atia.arzoo@cutm.ac.in
Received 15th Oct 2020 Accepted after revision 28th Dec 2020
Print ISSN: 0974-6455 Online ISSN: 2321-4007 CODEN: BBRCBA

Thomson Reuters ISI Web of Science Clarivate Analytics USA and Crossref Indexed Journal

NAAS Journal Score 2020 (4.31)

Online Contents Available at: http//www.bbrc.in/

resulting in their reduced growth and development [16, 17, 18, 19, 20, 21]. As nickel is an important heavy metal pollutant, this work was undertaken with an objective to determine its effect on the growth and development of *Sesamum orientale* L.

MATERIAL AND METHODS

Selection of plant material: *Sesamum orientale* L. belongs to an angiospermic family Pedaliceae and commonly called Til/Rassi is one of the most ancient oil seeds crop known to mankind. Sesame plays an important role in human nutrition. Most of the sesame seeds are used for oil extraction and the rest are used for edible purposes. Seeds of *Sesamum orientale* L. were obtained from "National Seed Corporation", Bhubaneswar. The seeds were stored in dark and cool place for experimental use.

Experimental Design: The present study was undertaken with nickel chloride solutions at 10, 20, 30, 40 and 50 ppm along with control (untreated). Twenty seeds of *Sesamum orientale* L. each of were surface sterilized with 0.1% mercuric chloride and washed thoroughly with tap water and then with distilled water. Twenty uniform sized seeds were placed in petri-dishes of 10 cm diameter with different concentrations of Nickel chloride solution (10, 20, 30, 40 and 50 mg of Ni) and one with control at a constant temperature of 26 °C. The seeds were submerged in 10 ml of test solutions and Hoagland nutrient solution twice a day. Each treatment was replicated five times. The number of seeds germinated in each treatment was counted on 5 days after sowing and the total germination percentage was calculated. Tolerance index and Vigour index of seedlings were calculated. This experiment was done in triplicates and the data was statistically analyzed and standard errors of mean (SEM) was calculated.

RESULTS AND DISCUSSION

Germination study: Significant changes were found in the germination of *Sesamum orientale* in different concentration of Ni. The germination percentage was decreased with increased concentration of Ni.

Table 1. Effect of Ni on seed germination of *Sesamum orientale* L. Seedling Values of 5 replicate ±SD

Concentration of Ni	Germination (%)	Radicle length (in cm)	Standard Vigour Index	Metal Tolerance Index	Pytotoxicity (%)
0.0 ppm (control)	85±1	8.4±0.3	714	100	0
10 ppm	85±2	8.4±0.2	714	100	0
20 ppm	60±1	7.55±0.25	453	89	10.11
30 ppm	57.5±1.5	7.05±0.05	405.37	83.92	16.07
40 ppm	47.5±1.5	6.55±0.05	311.12	77.97	22.04
50 ppm	37.5±0.5	5.56±0.25	211.87	67.26	32.73

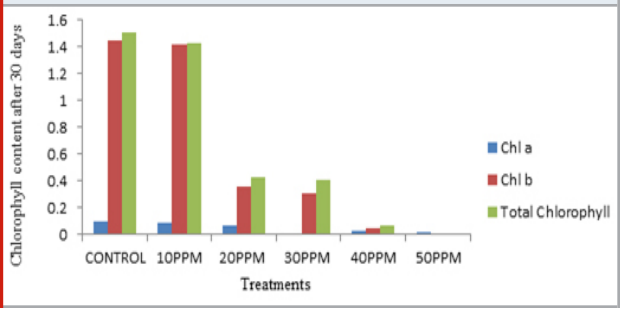
Observations on the germination study of *Sesamum orientale* L. depicted in Table 1. It was clearly indicated that the Seedling vigour index and Metal tolerance index were decreased with increase of concentration of Ni while the phytotoxicity was increased with increase of Ni concentration. The significant decreases in radical length of Sesamum orientale L. seedling suggest that low concentration of Ni was beneficial for seed germination.

Analysis of Biochemical Parameters

Effects on Chlorophyll content of Sesamum orientale L.: The effect of varied concentrations (10 ppm, 20 ppm, 30 ppm, 40 ppm, 50 ppm) of Ni with untreated soil on chlorophyll synthesis in *Sesamum orientale* L. seedlings have been depicted in Fig.1, 2, 3.

Concentration wise, the chlorophyll content after 30 days and 45 days of treatment was found to be increased while after 60 days of treatment the chlorophyll content was decreased.

Figure 1: Effect of different levels of Ni on the Chlorophyll content in *Sesamum orientale* L. after 30 days of treatment.



Effect of Ni on Soluble protein content of Sesamum orientale L.: There was gradual decrease in protein content with rise in different levels of Nickel concentrations.

Protein is produced in less amount when plants are subjected to environmental stress. Here protein content was found to be maximum when plants were subjected

at treatment of 10 ppm. But in both 30 and 45 daysof treatment protein content in 30 ppm concentration are nearly equal whereas the protein concentration was higher in *Sesamum orientale* L. after 60 days of treatment.

Figure 2: Effect of different levels of Ni in Chlorophyll content in *Sesamum orientale* L. after 45 Days of treatment

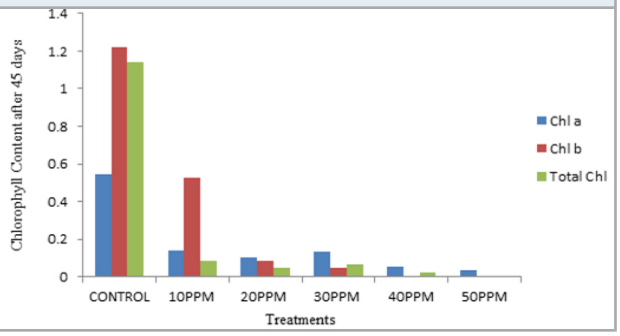
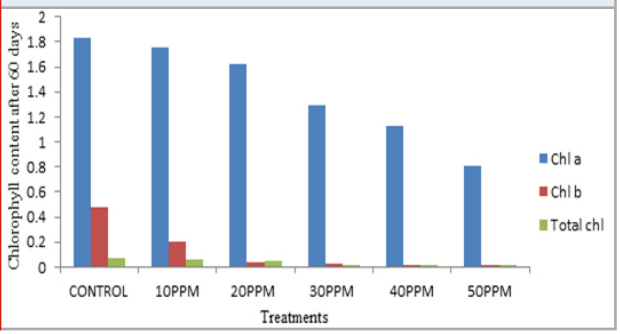


Figure 3: Effect of different levels of Ni on the changes in Chlorophyll content in *Sesamum orientale* after 60 days of treatment.



Effect of Nickel on Proline content of Sesamum orientale L.: Proline is produced in high amounts when plants are subjected to environmental stress. There was a gradual increase in proline content with rise in different levels of Ni which might be due to heavy metal stress.

The possible cause might be the stimulation of some of the enzymes of the proline biosynthetic pathways by Ni which caused the pronounced synthesis of proline at different level of Ni concentrations. There was a gradual increase in proline content with rise in levels of concentration of Ni. The maximum proline content was observed in seedling treated with 50 ppm of Ni and minimum in control irrespective of the days of treatments. Interestingly the proline content was observed to be highest after 45 days of treatment in all the concentrations of Ni.

CONCLUSION

Toxicity of heavy metals has received considerable attention partly due to its occurrence in nature and by mining activities. The data on growth parameter study showed that, with the increase in Ni concentration, the growth rate decreased progressively. Nickel at higher levels may inhibit the growth and development directly by inhibition of cell division or cell elongation or combination of both, resulting in the limited uptake and translocation of nutrients as well as water which causes mineral deficiency. At higher concentrations it acts as a toxic metal. From the result of this investigation, it can be concluded that Nickel at lower concentration has a stimulating effect on the germination process and seedling growth and will inhibit the same at higher concentrations.

Figure 4: Changes in Soluble protein content in *Sesamum orientale* L. after 30, 45 and 60 days of treatment.

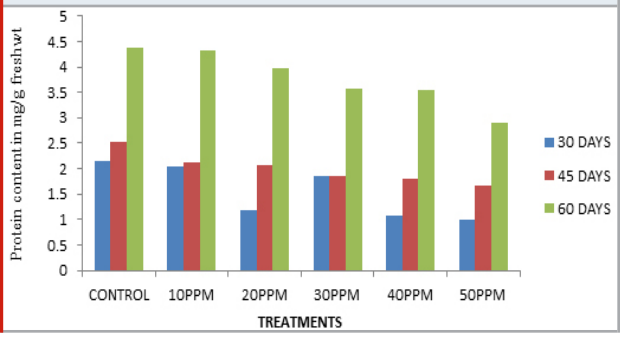
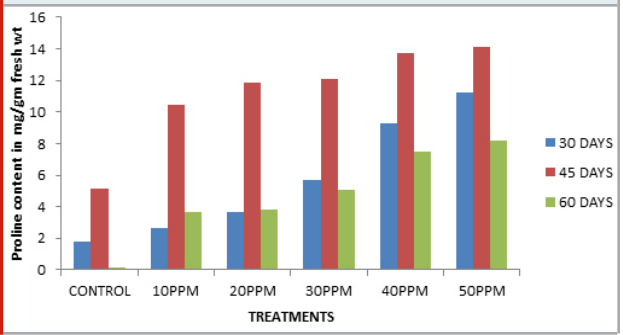


Figure 5: Effect of different levels of Ni on the Proline content after 30, 45 and 60 days of treatment.



AKNOWLEDGEMENTS

The authors are thankful to Centurion University of Technology and Management, Odisha for providing the necessary laboratory fascility during the research work.

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