THE EFFECT OF NICKEL ON SEED GERMINATION AND SEEDLING GROWTH OF Raphanus *sativus* cv. Jaunpuri

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Abstract

A laboratory experiment was conducted to study the effect of Nickel chloride on seed germination and seedling growth of *Raphanus sativus* cv. Jaunpuri. Various concentrations of Nickel chloride were used. Percentage of seed germination, seedling growth and their survival decreased with increasing concentration of nickel chloride. Delayed seed germination and cytotoxic effects on cell divisions were also noticed in the treated sets.

Keywords: *Raphanus sativus* , Nickel , Enzymes, Heavy metals.

Introduction:

Rapid industrialization and urbanization processes has led to the incorporation of pollutants such as petroleum products, chemical fertilizers, pesticides and heavy metals in the natural resources like soil, water and air thus degrading not only the quality of the environment, but also affecting both plants and animals. Although heavy metals are naturally present in the soil, anthropogenic and geological activities increase the concentration of these elements to amounts that are harmful to both plants and animals. Heavy metals including cadmium, chromium, copper, cobalt, lead, nickel and mercury are important environmental pollutants that cause toxic effects to plants. Presence of heavy metals in soil, water and air can cause bioaccumulation affecting the entire ecosystem and pose harmful health consequences in all life forms. Nickel (Ni) is reported to be toxic to most plant species affecting amylase, protease and ribonuclease enzyme activity thus retarding seed germination and growth of many crops. (Ahmad et.al., 2011) It has been reported to affect the digestion and mobilization of food reserves like proteins and carbohydrates in germinating seeds (Ashraf et.al.,2011), reducing plant height, root length, fresh and dry weight, chlorophyll content and enzyme carbonic anhydrase activity (Siddiqui, et.al.,2011). Nickle stress has been reported to affect photosynthetic pigments, lessen yield and cause accumulation of Na^+, K^+ and Ca^{2+} in mung bean. (Ahmad,et.al.,2007)

The radish (*Raphanus sativus*) is an edible root vegetable of the family Brassicaceae . It is a quick growing annual or biannual herb. Its edible roots are having different color from white to red. The lobed leaves form a basal rosette that emerges from the top of the root. Flower stalks usually appear in the first season, bearing white or lilac-veined flowers with four petals; the seeds are borne in a pod. Radishes owe their sharp flavor to the various chemical compounds produced by the plants, including glucosinolate, isothiocyanate and myrosinase. Radishes have an abundance of vitamins (B6, C), minerals (calcium, copper, iron, magnesium, manganese, phosphorous, potassium, zinc) and fibers. Radishes are also used to treat illnesses such as sore throat, bronchitis, fever, colds, cough, stomach and intestinal disorders, liver problems, bile duct problems, gallstones, loss of appetite and inflammation in Ayurveda and Traditional Chinese Medicine.

The present work was undertaken to study the effect of Nickel chloride on seed germination and seedling growth of *Raphanus sativus* cv. Jaunpuri.

Material and Methods:

Radish (*Raphanus sativus* cv. Jaunpuri) seeds were used for experiments. Seeds of test plants were selected on the basis of uniformity in size, shape, colour & weight. Seeds were surface sterilized with 0.1% $HgCl_2$ solution and thoroughly washed with distilled water .The different concentrations of nickel (100, 300 and 500 μM) were prepared in double distilled water using nickel chloride.

For seed germination, sterilized seeds were soaked in different concentrations of nickel chloride solution for their whole imbibition period. Seeds soaked simultaneously in distilled water constituted the control set. Thereafter, seeds were washed thoroughly with distilled water and transferred to petridishes lined with moist filter paper and kept in dark for germination. The experiment was performed in triplicate.

Percentage of seed germination in selected concentration was recorded after observing radicle emergence .The percentage of germination was calculated from the number of seeds showing radicle emergence out of total number of seeds kept in petridishes. The growth parameters like plumule and radicle length were observed on 10^{th} day after radicle emergence. The data observed in the experiment, were statistically analyzed for the calculation of standard error.

For mitotic studies root tips of germinating seeds were fixed in acetic alcohol (1:3) and squashed in 2% of acetocarmine. Number of normal and abnormal cells and types of chromosomal abnormalities were noted in all concentrations. A control set in identical condition was also managed.

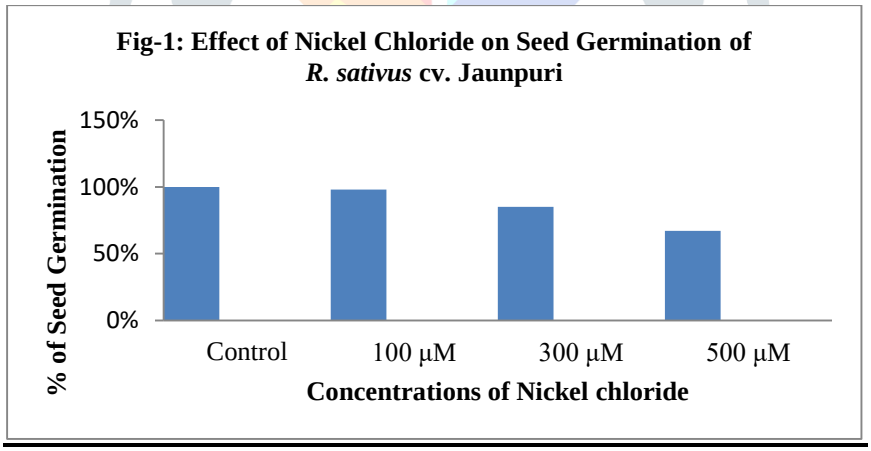
Result and Discussion:

The Results obtained in the experiments are shown in table-1 and fig. – 1 & 2. The primary effect of nickel on seed germination showed a tendency of delay in germination in contrast to control. Increase of concentrations gradually lowered the percentage of seed germination from 98% to 67%. The survival of seedlings also followed the same trend as revealed from table where survival of seedling decreased from 96 % (at lowest concentration) to 59% (at highest concentration).

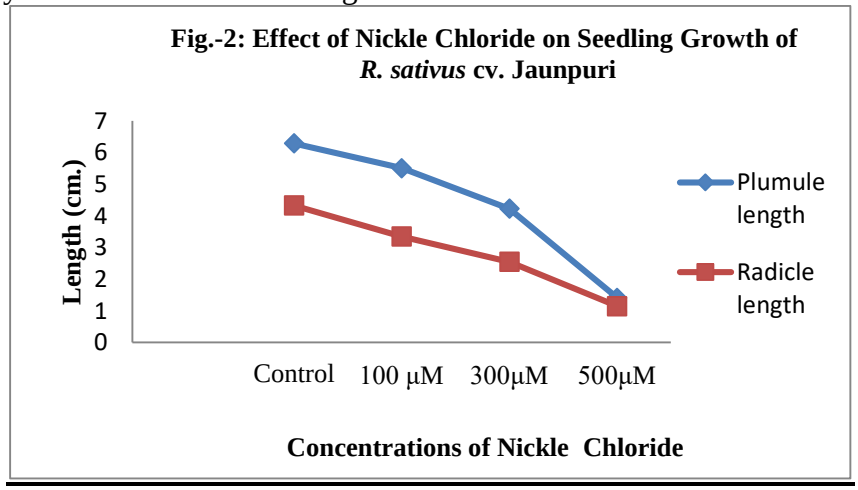
Table-1: Effect of Nickel on Seed Germination and Seedling Growth of *R. sativus* cv. Jaunpuri

Concentration of Nickle Chloride	% of Seed germination	Hours taken into germination	% of Survival of Seedlings	Length of Plumule after 10 days (c.m.)	Length of Radicle after 10 days (c.m.)
Control	100%	48 -50	98%	6.29 ± 0.25	4.33 ± 0.22
100 µ M	98%	47-56	96%	5.51 ± 0.33	3.35 ± 0.28
300 µ M	85%	70-85	85%	4.23 ± 0.22	2.55 ± 0.40
500 µ M	67%	88-120	59%	1.41 ± 0.24	1.15 ± 0.10

The average of three triplicates ± S.E.



This treatment had not only affected the % of seed germination and survival of seedlings but growth of seedlings too gradually decreased with increasing concentration of nickel chloride.



Similar trend of decrease in percentage of seed germination and survival of seedlings with increasing concentrations of Nickle chloride have also been reported by Mukherji et. al. (1974), Singh and Singh (1996) and Farooqui et.al. (2009). Decrease in percentage of seed germination and delayed emergence of seedling with increasing concentrations may be attributed to the presence of certain inhibitory or toxic substances which might disturb the metabolic activity (Ananthaswamy, et.al., (1971), hence delayed emergence of seedlings. Decline in percentage of seed germination with increasing concentration clearly indicates the presence of more toxic substances in higher concentrations than that of lower concentration. These toxic substances damage some of enzyme system involved in the metabolism and repair mechanism, thus directly affects the cell division and cell elongation, hence retardation in the growth of seedlings.

The most remarkable response of nickel chloride on cell division is steep decrease in mitotic activity with gradual increase in concentration which was quite normal in control. Chance in the proportion of nuclei undergoing division is partial index of the degree and kind of effect of the given treatment. Increase of prophase at lower concentration (100µM) and significant decrease in metaphase and anaphase, inhibition of anaphase at 300µM and complete inhibition of cell division in 500µM concentration indicate that lower concentration prevent cell cycle at the end of prophase , while middle concentration breaks the spindle fibers and higher concentration prevent the entry of cell into mitosis. This finding clearly indicates that the lower concentrated solution has less amount of toxic substances while middle concentrated solution has more toxic substances. At higher concentration these toxic substances almost completely check the mitotic division. Similar cytotoxic effects have been reported by Prasad and Haider (1981) and Gulfishan et. al.(2010).

Thus the present investigation suggest that nickel chloride solution has enough chance to induce genetic disturbances. Hence, it needs further research in order to have a better understanding of the mechanism of the mutagenic effect of nickel chloride.

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