Changes in Seedling Growth and Biochemical Contents in *Abrus precatorius* L. Under Nickel Treatment

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**Abstract**

An attempt was made to study the effect of nickel on the growth of *Abrus precatorius*, a medicinal plant growing in South Gujarat used in Ayurved. The seeds of *Abrus precatorius* were germinated in petri dishes by 25, 50, 100, 150, 200 ppm nickel sulphate solution for experimental work. The germination percentage, seedling growth, dry matter yield and changes in biochemical contents of total sugar, protein and pigments were investigated ten days after showing. The study indicates that the lower level of nickel has no adverse effect on germination, seedling growth and biochemical content whereas the higher concentration decreased the same accept the protein. Nickel increased the protein content at lower concentration and has been reducing effect at higher level.

**Keywords:** Seedlings, Nickel, *Abrus precatorius*

**1 Introduction**

In the South Gujarat region of the India a large industrial area has been developed, which is known as “Golden Corridor”, where large numbers of various types of industries are present. Most of them are chemical, dye, textile, pesticide, pharmaceutical industries, which produce effluent containing heavy metals which contaminate nearby water bodies and sometime certain industries discharge such effluents into lakes and rivers. Such effluent may causes toxicity in the aquatic plants, animals and soil pollution. Irrigation of polluted water, industrial exhausts, and the pesticides as well as fertilizers used in agriculture may cause the contamination of medicinal plants with heavy metals.

Certain heavy metals at higher concentration inhibits a cytoplasmic enzymes and damage to cell - structures. A precise study of the toxic effect of heavy metals on plant growth, biochemical and various physiological processes was carried out by Chibuike and Obiora. According to certain heavy metals like Pb, Cd, Hg, and As has adverse effect on plant growth even at very low concentration. Kibra studied the effect of Hg on the growth of rice plant and reported significant reduction in height. He also reported reduced tiller and panicle formation under the effect of Hg. The study of Ahmad *et al* has shown that Cd caused the reduction in the growth of root and shoot in wheat plants at the concentration of 5 mg/L. According to Kabata - Pendias the reduction in plant growth is due to reduction of photosynthesis, plant nutrients and enzyme activity.

The use of herbal drugs increases day by day in the present days. Along with the higher demand of herbal drugs, it is necessary that the quality of drugs prepared from the plant must be assured for the utilization. The study of heavy metals pollution is necessary for the overall safety and quality of herbal drugs.

*Abrus precatorius* is a widely growing medicinal plant of South Gujarat. It is a beautiful, perennial wiry, twining climber with weak stem and pinnate and opposite leaves. Flowers are pink or pinkish white and found in auxiliary racemes. Fruit pods are turgid with a sharp deflexed beak, pubescent, linear - oblong, mucronate. Seeds 3 - 5, subglobose, oblong or ovoid.

It is an important medicinal plant used for treatment of diarrhoea, *dyentery* and gonorrhea. Plant is used in some traditional medicine to treat wounds, sores and scratches caused by dogs, cats, mice and also used with other ingredients to treat leucoderma. Decoction of dry roots is also used to treat bronchitis and hepatitis. Leaves are sweetish in taste and are useful in biliousness, itching and other skin diseases. Seeds administrated in affections of nervous system, and their
paste is applied locally in stiffness of shoulder joints and paralysis.\(^7\)

Few workers contributed on the chemical constituents of *Abrus precatorius*. Major constituents are abrasiene, abro\(^{18}\), abrin\(^{19}\), abruquinones\(^{30}\), abrusgenic acid, methyl abrusgenate and abruslactone A\(^21\).

Several workers carried out pharmacological experiments on *Abrus precatorius*. Ethanolic and petroleum ether extracts of root showed anti - implantation activity in rat\(^{22}\). Aqueous extract of the root showed antischistosomal activity\(^{23}\). Further, ethyl acetate and methanol extract exhibited *in vitro* antimalarial activity against *Plasmodium falciparum*\(^{24}\). Various extracts of the seed of *Abrus precatorius* showed *in vitro* anti - microbial activity\(^{25}\), larvicidal activity\(^{26}\) and antifertility activity in rats\(^{27},^{28}\).

The present investigation were carried out to find out the effect of different concentrations of nickel on seed germination, seedling growth and bio chemical content of *Abrus precatorius*.

### 2 Materials and Methods

#### 2.1 Collection of plant material

The experimental plant *Abrus precatorius* belongs to the family Papilionaceae\(^{29}\). Its seeds were collected from the widely grown plant in the campus of V. N. South Gujarat University, Surat of India and sterilized with 0.2% mercuric chloride for the experimental study.

#### 2.2 Experimental procedure

Ten seeds were placed in petridishes lined with filter paper. The various concentration of nickel sulphate solution (25, 50, 100, 150 and 200 ppm) were prepared and used for the seed germination and growth studies. The seed germinated with distilled water was treated as control. The germination percentage, seedling growth, dry matter yield and biochemical contents were studied ten days after showing. The results are the average of three replicates.

For the study of dry weight the root and shoot were cut into small pieces and placed separately in brown bags after weighing and kept in oven at 80 °C for a period of 8 days for drying. The dry weight of these organs was recorded.

The biochemical estimation of total sugar was studied by Nelson\(^{30}\) method in which the amount of sugar was calculated from optical density obtained by spectrophotometer. Similarly the protein content was determined from optical density following the procedure of Lowery et al\(^{31}\). For the pigment determination acetone extract of fresh leaves was used and the amount of chlorophyll a, chlorophyll b and carotenoid were calculated by using the formulae given by Machlachlan and Zalk\(^{32}\) and Duxbury and Yentsch\(^{33}\).

### 3 Results and Discussions

#### 3.1 Germination and growth

Present study has showed no effect of the lower concentration of nickel on the germination of seed, growth of root and shoot and dry matter yield. The treatment of higher concentration of nickel reduced the germination, growth of root and shoot and dry matter (Table 1). Similar reduction in shoot and root mass due to higher concentration of nickel was also found in green gram by Vijayarengan and Lakshmanachary\(^{34}\) and in *Phaseolus vulgaris* by Piccini and Malavolta\(^{35}\). The reduction in seed germination and growth attributed to the toxic effect of higher concentration of nickel as suggested by Seregin and Kozhevnikova\(^{36}\).

#### 3.2 Biochemical studies

The lower level of nickel up to 25 ppm concentration has no effect on pigments like chlorophyll a, chlorophyll b and carotenoid of leaves. Further, higher nickel level decreased the chlorophyll and carotenoid content (Table 2). Panday and Sharma\(^{37}\) found decreased in chlorophyll content in tomato plant due to exposure of excess concentration of nickel peroxidase. They found that this is associated with the reduction in the activities of Fe enzymes, catalase and peroxidase causing the reduction in pigment content. Kaveriammal and Subramani\(^{38}\) also suggested that decrease in chlorophyll content due to heavy metal stress is the result of the inhibition of enzymes responsible for the chlorophyll biosynthesis.

Protein content was higher than control at lower concentration of nickel (25 and 50 ppm), further the values decreased with increased in nickel level (Table 3). Similar result about influence of nickel was obtained by Sanghpiya and Panday\(^{39}\) and Ghasemi et al\(^{40}\) in *Zea mays*. According to Palma et al\(^{41}\) the decrease in protein content by the treatment of higher concentration of nickel may due to degradation of protein molecules. Such reducing effect also may be due to inhibition of protein synthesis by higher concentration of nickel\(^{42}\).

Total sugar content remains unaffected at lower concentration of nickel but reduced at higher level of nickel (Table 3). These results are similar to the finding of Ezhilvannn et al\(^{43}\) in *Arachis hypogaea* and Espar et al\(^{44}\) in radish. Rabie et al\(^{45}\) reported decrease in carbohydrates with respect to the high levels of nickel in corn and broad bean and suggested that this decline is due to a role of nickel on the enzymatic reactions related to the cycles of carbohydrates catabolism.

### 4 Conclusion

From the present study, it was revealed that the lower concentration of nickel has no adverse effect on germination, seedling growth, dry matter yield and biochemical content of *Abrus precatorius*. Higher concentration has an inhibitory effect on these parameters.

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Table 1: Effect of nickel on germination, growth and dry matter yield

<table>
<thead>
<tr>
<th>Concentration (ppm)</th>
<th>Germination (percentage)</th>
<th>Root length (cm)</th>
<th>Shoot length (cm)</th>
<th>Root dry weight (gm/plant)</th>
<th>Shoot dry weight (gm/plant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>96±0.81</td>
<td>6.80±0.08</td>
<td>10.92±0.08</td>
<td>0.212±0.009</td>
<td>0.348±0.008</td>
</tr>
<tr>
<td>25</td>
<td>96±0.81</td>
<td>6.65±0.12</td>
<td>11.08±0.21</td>
<td>0.204±0.004</td>
<td>0.356±0.008</td>
</tr>
<tr>
<td>50</td>
<td>95±0.81</td>
<td>6.95±0.07</td>
<td>10.82±0.15</td>
<td>0.220±0.004</td>
<td>0.336±0.008</td>
</tr>
<tr>
<td>100</td>
<td>90±0.81</td>
<td>5.48±0.32</td>
<td>9.20±0.04</td>
<td>0.196±0.001</td>
<td>0.272±0.002</td>
</tr>
<tr>
<td>150</td>
<td>88±0.81</td>
<td>5.08±0.09</td>
<td>8.68±0.15</td>
<td>0.172±0.001</td>
<td>0.260±0.001</td>
</tr>
<tr>
<td>200</td>
<td>84±0.81</td>
<td>4.80±0.30</td>
<td>7.80±0.12</td>
<td>0.158±0.001</td>
<td>0.242±0.012</td>
</tr>
</tbody>
</table>

Data in parenthesis represent percentage changes.

Table 2: Effect of nickel on leaf pigments (mg/gm)

<table>
<thead>
<tr>
<th>Concentration (ppm)</th>
<th>Chlorophyll a (mg/gm)</th>
<th>Chlorophyll b (mg/gm)</th>
<th>Carotenoid (mg/gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1.90 ±0.06</td>
<td>2.14 ±0.20</td>
<td>1.10 ±0.06</td>
</tr>
<tr>
<td>25</td>
<td>1.83 ±0.06 (-3.68)</td>
<td>2.12 ±0.06 (-0.93)</td>
<td>1.08 ±0.04 (-1.82)</td>
</tr>
<tr>
<td>50</td>
<td>1.86 ±0.05 (-2.11)</td>
<td>2.08 ±0.04 (-2.80)</td>
<td>1.06 ±0.08 (-3.64)</td>
</tr>
<tr>
<td>100</td>
<td>0.92 ±0.08 (-51.58)</td>
<td>1.78 ±0.08 (-16.82)</td>
<td>0.78 ±0.06 (-29.09)</td>
</tr>
<tr>
<td>150</td>
<td>0.84 ±0.04 (-55.79)</td>
<td>1.52 ±0.05 (-28.97)</td>
<td>0.70 ±0.04 (-36.36)</td>
</tr>
<tr>
<td>200</td>
<td>0.66 ±0.06 (-65.26)</td>
<td>1.32 ±0.06 (-38.32)</td>
<td>0.62 ±0.06 (-43.64)</td>
</tr>
</tbody>
</table>

Data in parenthesis represent percentage changes.

Table 3: Effect of nickel on total sugar and protein (mg/gm)

<table>
<thead>
<tr>
<th>Concentration (ppm)</th>
<th>Total sugar (mg/gm)</th>
<th>Protein (mg/gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stem</td>
<td>Root</td>
</tr>
<tr>
<td>Control</td>
<td>4.20 ±0.28</td>
<td>3.40 ±0.18</td>
</tr>
<tr>
<td>25</td>
<td>4.15 ±0.35 (-1.19)</td>
<td>3.37 ±0.32 (-0.88)</td>
</tr>
<tr>
<td>50</td>
<td>4.12 ±0.21 (-1.90)</td>
<td>3.35 ±0.26 (-1.47)</td>
</tr>
<tr>
<td>100</td>
<td>3.60 ±0.25 (-14.29)</td>
<td>2.75 ±0.32 (-19.12)</td>
</tr>
<tr>
<td>150</td>
<td>3.08 ±0.15 (-26.67)</td>
<td>2.40 ±0.38 (-29.41)</td>
</tr>
<tr>
<td>200</td>
<td>2.78 ±0.11 (-33.81)</td>
<td>2.02 ±0.28 (-40.59)</td>
</tr>
</tbody>
</table>

Data in parenthesis represent percentage changes.

6 Conflict of interests
Authors have no conflict of interest.

7 Author’s contributions
Entire investigation was carried out by MV.

8 References


10. Hembrom PP. Contact therapy practiced by Mundas of Chotanagpur (Bihar). Ethnobotany. 1996; 8 (1 and 2) : 36 – 39


