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Anatomical Changes in Seedling of Pisum Sativum Linn. Under The Nickel Stress

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Abstract: ***A research investigation was conducted to find out how Nickel's different stresses affected the morphological alterations in Pisum sativum. Pisum sativum has a complex stem structure. In the transactional view, the stem of Pisum sativum is usually more or less square-shaped. The root's transverse section has a form which is slightly rounded. The structural abnormalities of Pisum sativum treated with different concentrations of Nickel indicated its toxic effect on the anatomical structure of the root and stem. Pisum sativum treated with lower to higher doses of Nickel showed few specific effects on stem anatomy. Plants treated with nickel had many structural changes in their roots.***

Key Words: Anatomical Structure, Abnormalities, Transverse Section.

I. INTRODUCTION

Due to their negative impact on plants, heavy metals have recently attracted the attention of academics all over the world. All heavy metals are harmful above the critical tissue content for any plant species, even though many of them are actually necessary for plant growth (Macnicol and Beckett, 1985[14]; Marschner, 1995[15][26][27]).

A component of the enzyme urease, which is necessary for nitrogen metabolism in higher plants, nickel is also a micronutrient that is crucial for plant growth (Dixon et al., 2004[7]). For plants to function normally metabolically, trace elements are necessary as micronutrients; but, at larger concentrations, they become poisonous (Seregin and Kozhevenikova, 2006[20]; Chen et al., 2009[6]). High concentrations of Ni are very phytotoxic (Barcelo et al., 1990[5]; Baccouch et al., 1998[3][23][24][25]). The most typical signs of Ni toxicity in plants include inhibition of growth, photosynthesis, seed germination, sugar transport, and induction of chlorosis, necrosis, and wilting (Ali et al., 2009[2]; Leon et al., 2005[13]; Ahmad et al., 2009[1]).

While chloroplasts of the bundle sheath cells of Zea mays seedlings fed on 60 M nickel showed a considerable increase in starch quantity, the leaves of the plants displayed evidence of histological abnormalities (Huillier, 1996[12]). Due to abnormal root system structure and effects on shoot and root length, nickel was discovered to be toxic (Garg and Chandra, 1990[9]; Pandit and Prasanna, 1999[16]; Seregin et al., 2003)[19]) performed an experiment on maize roots and discovered that nickel accumulation in the pericycle restricted root branching). Although the final cell length was unaffected by nickel, reduced cell division was the cause of the root development inhibition.

One of the agricultural crops grown in south Gujarat is *Pisum sativum* Linn. Fabaceae. The field pea, a legume with a native range of Southwest Asia, was one of the first agricultural products of humankind. 5,389 106 ha of field peas are produced globally, with Canada, China, India, and Russia being the top four producers. Peas are a good source of lutein, vitamin B, and vitamin A. *Pisum sativum*, one of the world's oldest crop plants and one of the most significant of the legumes, is now widely grown in temperate areas and at higher altitudes in the tropics. Pea seeds are likewise pricey, but the ability of this species to fix nitrogen and the reduced need for fertilizers make up for it. then the pea plant

Therefore, the current study is concentrated on the harmful effects of the heavy metal nickel (Ni) on *Pisum sativum* L (Sweet pea), a plant that is commonly farmed in Gujarat.

II. MATERIALS AND METHODS

Germination procedure conducted in petri dishes. To prevent surface bacterial/fungal contamination, seeds were H2O2-surface sterilized. NiCl2 were used in the lab to prepare different ppm solutions in pure distilled water, and pure distilled water worked as the study's control. In each petri dish, ten seeds were placed on cotton, and 40 ml concentration of the solution each were given once for seed germination. After this treatment, tap water has been used every other day. Every day, fungus and other tests were performed on the petri dishes.

Plants determined the sub lethal (LC20), lethal (LC50), and super lethal (LC80) values for each metal. The experimentation began 20 days after the seeds were sown. The parameters of anatomical abnormality were studied.

III. ANATOMY STUDIES

The plant's selected sections, such as the roots and stem, are cut into 10 to 15 cm sections and preserved in the deadly chemical formalin-acetic acid-alcohol (FAA). To study the plant material in cross sections, manual sectioning was done. During sectioning, the material was stained using Safranin and Fast-green stains and placed on glass slides with just a drop of glycerin jelly. This was covered with such a cover slip, and observations were made.

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IV. PHOTOGRAPHY

The photos of anatomical structure of stem and root of *Pisum sativum* were shot using a Sony T-10 digital camera and an X5 zoom lens. The pictures were uploaded to an IBM ThinkPad laptop, and then prints were made on an HP-4288 printer. With a Carl-Zeis photomicroscope with planophotochromatic objectives and Kodak 100 ASA-35mm colour film, photomicrographs were taken. Green, yellow, or daylight filters were applied.

V. RESULT

A. Anatomical studies

a. Stem

Pisum sativum's stem anatomy is absolutely interesting. In the transactional view, the stem of *Pisum sativum* is usually more or less square-shaped. Epidermis, hypodermis, cortex, endodermis, pericycle, vascular system, and pith make up the majority of the stem's anatomical components.

The epidermis' outer wall does have a thin layer of cuticle (Plate 1.E, F). The epidermis has one layer. Stomata are also seen in the epidermis, and epidermal cells are small and tubular in structure (Plate 1.E) (Plate 1. F).

The layer below the epidermis is the hypodermis (Plate 1. E, F). Crystal is also present in the cortex cell (Plate 2. B), which is smaller than the cortical cells and has a wavy cell wall. Zigzag endodermis is also seen beneath the cortical cells (Plate 2. C, D, F). pericycle with a single layer that lies below the endodermis. At the centre of the vascular cylinder (Plate 18. A), large pith parenchyma cells were found. When the plant matures, metaxylem will occupy these cells (Plate 2. C, D). In *Pisum sativum,* the change from root structure to stem structure is not complete until the third internode. Exarch bundles are present in the first and second internodes of this anomaly, and at least a piece of the first internode is protostelic. The triarch configuration of the root changes to six distinctive vascular bundles in the first internode in the area of the cotyledonary node. They are made up of four elongated lateral bundles that are positioned on either side of the tiny central pith and in the direction of the elliptical stem's long axis (Plates 1, 2).

The six vascular bundles, two cortical fibrovascular bundles, and two groups of cortical fibres are all visible throughout the stem architecture (four lateral exarch and two endarch at either end) (Plate 18. A). Cortical ground tissue contains cortical fibrovascular bundles and fibre groups (Plate 1. B, C, D). While the metaxylem elements are in touch, the four lateral exarch vascular bundles appear as two bundles; nevertheless, when they mature, the four lateral exarch VBs merge (Plate 2. C, D, E, F). Except for the minor bundles at either end of the lateral groups, all of the bundles in the series are exarch. Endarch refers to these two vascular bundles located at each pole (Plate 2. A, E).

Plate 1

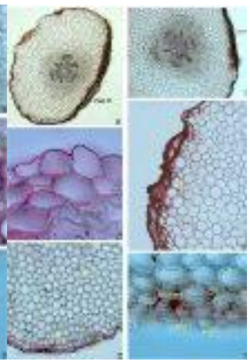

Plate 2

b. Root

The root's transverse part has a form slightly rounded. The *Pisum sativum* root has an epidermis with root hair, a single layer of hypodermis, cortex, endodermis, pericycle, and vascular system in normal conditions.

The epidermis has one layer. Root hairs are compactly arranged, and the cells are more or less horizontally flattened. It is a single-celled outgrowth of epidermal cells. Under the epidermis, there occurs a single layer of the hypodermis (Plate 3. C, F).

Under the hypodermis, a large cortex can be observed. It is significant and made up of intercellular gaps and parenchyma cells of various shapes and sizes. The endodermis is the innermost layer. It has only one layer. The cells have a distinct casparian band on the radial walls, are barrel-shaped, and are compactly arranged (Plate 3. A, B, C, D). The pericycle is located next to the endodermis. It is parenchymatous and has a single layer. The vascular bundle has triarch xylem and is radial. Protoxylem is towards, so the xylem is exarch. The metaxylem and pericycle side are located in the center. Three phloem patches and three xylem patches are positioned alternately. There is a little amount of conjunctive tissue, a thin-walled parenchyma, located between xylem and phloem patches. Between each phloem patch and the pericycle, a small amount of sclerenchyma develops (Plate 3. E).

Metaxylem occurs where the pith must be. Early on, a little pith is present, but as the plant develops, it disappears, leaving the metaxylem vessels to occupy the space.

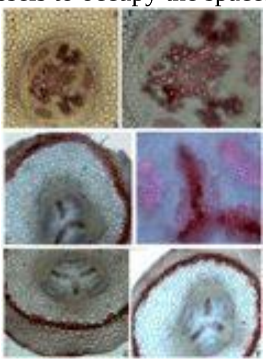

Plate 3

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B. Effect of Nickel on stem

When *Pisum sativum* was treated with different concentrations of nickel, structural anomalies formed that showed the toxic effects on the root and stem's anatomical structure.

a. Nickel

After nickel treatment at concentrations ranging from low to high, no significant effect was found. A single layer of epidermis is present (Plate 4. B), together with a hypodermis and cortex that are located below the epidermis, a fibrous strand, a cortical vascular bundle, and, after 15 days of plant stem growth, secondary growth in the vascular system (Plates 4. E and 22. F).

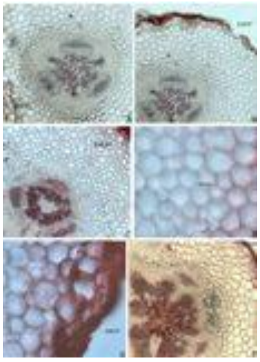

Plate 4

C. Effect of Nickel on root

a. Nickel

Pisum sativum that had been treated with 75 ppm of nickel exhibited a number of root anatomical anomalies. The nickel treatment of root anomalies observed in epidermal cells damaged epidermis observed throughout the epidermis (Plate 5.A, B), many root hairs were also harmed and ruptured epidermis was identified in *Pisum sativum*. Some of the cortical cells and some of the pith parenchyma cells lignified (Plate 5. C). Suberin deposition and a casperian strip were also present in the endodermis layer (Plates 5. D, E), and after 10 days nickel had penetrated the root tissue through the root hair.

When *Pisum sativum* was treated with 100 ppm of nickel, several anomalies were found. Due to cell death and cortical rupture, part of the epidermal layer turned brown (Plate 6. A, B). Nickel was introduced through the root hair and branch root systems as well (Plate 6.. C). The following are some more anomalies brought on by the treatment of nickel:

1. The cortical tissue had been infected with nickel (Plate 6. D).
2. Degeneration of tissue (Plate 6. E).
3. Cortical cell breakdown and epidermal loss (Plate 6. F)
4. Cortical cells became larger, showing abnormal tissue development, as well as the loss of epidermis, hypodermis, and cortical cells (Plate 7. A, B).
5. Epidermal layer damage (Plate 7. C, and E).
6. Cortex has abnormal cell division (Plate 7. C, D, E, and F).
7. Cortical cells that had been damaged became larger, showing abnormal tissue development (Plate 8. A).
8. Cortex cells, endodermis, and VBs are all damaged (Plate 8. B).
9. abnormal development of vascular tissue (Plate 8.C, D).
10. Pith parenchyma lignifications (Plate 8. E, F).

The treatment of *Pisum sativum* with 125 ppm nickel led to a number of morphological anomalies. In roots, epidermal, hypodermal, and some cortical cell death resulted in cells turning brown (Plates 9. A, B), damage to the epidermis, ruptured cortical cells, aberrant tissue growth in the vascular system, and ruptured epidermis.

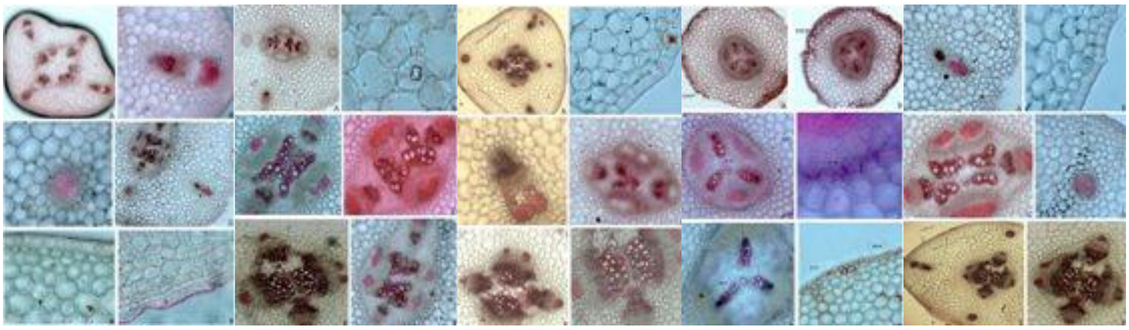

Plate 5 **Plate 6** **Plate 7** **Plate 8** **Plate 9**

VI. DISCUSSION

A. Anatomical studies

In our investigation, different nickel concentrations had a greater impact on the root morphology of *Pisum sativum* and a lesser impact on the stem structure.

Pisum sativum has a triarchic root. In comparison with controls, the root's triarch indicated it was entirely altered in nickel-treated plants. Parenchyma cells, the root cortex, and the root pith all showed significant decreases after nickel treatments. As already demonstrated by Sieghardt (1984)[22] and Barceló et al. (1986)[4], the significant reduction in cell size in our current study may be related to a reduction in the root's cell walls' flexibility. Heavy metal treatment resulted in a decrease in the diameter of wheat roots and the transectional area of cortical cells (Setia and Bala, 1994[21]). Additionally, in various root tissues of several plant species, cell wall thickenings occur. These alterations, known as phi thickenings, are made to the middle section of the radial cell walls. According to Guttenberg (1968)[11], Peterson et al. (1981)[17], and Eschrich (1995)[8], they can either form a uniseriate or multiseriate layer.

The most notable outcome, which affects the metaxylem vessels' ability to function as translocation conduits, was a reduction in their diameter (Poschenrieder and Barceló, 1999[18]). As a result, the amount of water and mineral flow via the xylem from root to shoot may be reduced. Consequently, as shown by Greger and Johansson (1992)[10] in sugar beetroot, plants may need to reduce water loss through transpiration. With the exception of when combined, nickel had an impact on stem thickness, but it significantly reduced the diameter of the roots.

VII. CONCLUSION

In our study, different nickel concentrations had more of an effect on *Pisum sativum's* root anatomy than its stem structure. *Pisum sativum* has a triarchic root. Compared to controls, the root's triarch indicated it was entirely altered in nickel-treated plants. Treatments with nickel significantly reduced the number of parenchyma, root cortex, and root pith cells. They cause aberrant cell division in cortical cells as well as abnormal cortical cell expansion. Ectopic lignifications are also observed in the pith parenchyma cells as a result of the harmful effects of these heavy metals. Cell death was the result of these hazardous metals' final impacts.

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Availability of Data and Material/ Data Access Statement	Not relevant.
Authors Contributions	I am only the sole author of the article

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