EFFECTS OF NI AND ZN ON GROWTH OF VIGNA MUNGO, VIGNA RADIATA AND GLYCINE MAX

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ABSTRACT

Heavy metals and other pollutants in the environment damage to the plants. Heavy metals include lead (Pb), cadmium (Cd), zinc (Zn), arsenic (As), nickel (Ni), chromium (Cr), copper (Co) etc. A pollutant is any substance in the environment, which causes objectionable effects, impairing the welfare of the environment, reducing the quality of plant life and may eventually cause plant death. Such a substance has to be present in the environment beyond a set or tolerance limit, which could be either a desirable or acceptable limit. Hence, environmental pollution is the presence of a pollutant in the environment viz. air, water and soil, which may be poisonous or toxic and cause harm to plants in the polluted environment. Increases of metal content ions when present at an elevated level in the environment are absorbed by roots of the plants and translocated to different plant parts, leading to impaired metabolism and reduced growth and Ni and Zn considered as essential micronutrients, increased concentration poses toxicity on metabolic and cytological activity of the plants. In the present investigation, the three plant of Indian pulses *Vigna mungo, Vigna radiata* and *Glycine max* which is the major pulses for farmer and all, were taken and the effect of different grade of Ni and Zn observed for the growth in pulses. The plant of one week and one month were taken for the present study. It was observed that the Ni and Zn had reduced cytological activity in the growing plant contrasting to control plants. They, thus reduce the plant growth in excess.

KEYWORDS

Heavy metals, translocation, cytological activity, plant growth.

INTRODUCTION

India is an agricultural country, about 70% population of the country living in villages and depends on their farming. The presence of large amount of elements i.e. metals in the environment have become a common issue of pollution. However, metals are a natural part of terrestrial systems and occur in soil, rock, air, water and organisms. A few metals, including Ni, Zn, Cu, Mn etc are required as trace elements by the plants. It is only when metals are present in bioavailable forms. The fraction of the metals which plant can absorb is known as the available or bioavailable fraction. Metals present in soil can be divided into a number of fractions including; the soluble metal in the soil solution, metal-precipitates, metal absorbed to clays, hydrous

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oxides and organic matter and metals within the matrix of soil minerals. These different fractions are all in dynamic equilibrium with each other. However, while the soluble metal in the soil solution is directly available for plant uptake other soil metal pools are less available. Metals within the soil solution are the only soil fraction directly available for plant uptake (McBride 1997: Whitehead, 2000). Hence, factors which affect the concentration and speciation of metals in the soil solution will affect the bioavailability of metals to plants. Soil factors which have an affect on metal bioavailability include the total metal present in the soil, pH, clay and hydrous oxide content, organic matter and redox conditions. Generally, metal toxicity issues do not arise in natural soils with their native vegetation. Even if the soil is naturally high in a particular metal, native plants will often have become adapted over time to the locally elevated levels (Ouzounidou 1994). Most metal toxicity occurs as a result of anthropogenic disturbance, such as mining, where unnaturally high amounts of metals are released during various processes (Helmisaari et al., 1995). The immediate source of nutrient and metal ions to a plant is from the soil solution (McBride 1997: Whitehead, 2000). The percentage of any metal occurring in the soil solution is usually small compared to the total metal pool in the soil. Metals in the soil solution are in dynamic equilibrium with the largest soil fraction, and so, as metals are removed from the soil solution by plant uptake, or by other processes such as leaching, replenishment of the soil solution will occur. This replenishment can come from exchangeable ions, adsorbed salts, precipitated compounds and mineralization of organic matter and weathering of soil minerals (Whitehead, 2000).

MATERIAS AND METHODS

The seeds of black gram (*Vigna mungo*), mung bean (*Vigna radiata)* and soya bean (*Glycine max*) were collected from local breeder**.** The earthen pots filled with proper sand and soil under favorable condition. All these pots were categorized into three groups' viz. C (Control), N (Nickel) and Z (Zinc). Group- C had CB, CM and CS, Group- N had NB, NM and NS and Group-Z had ZB, ZM and ZS named respectively. C= Control, N= Ni (Nickel), Z= Zn (Zinc), B= Black Gram, M= Mung Bean, S= Soya Bean.The three sets of pot provided proper water supply and sunlight for germination of seeds and growth of plants. The seeds of all three varieties of pulses were sown in pots during April-June. The stock solution of $ZnSO_4$ and $NiCl_2$ were prepared 1M as standard method given by Gupta 2004. The soil of 1st set of pots were considered as control, 2nd set of pots treated with $NiCl_2$+ EDTA solution (100 mg/Kg) and the 3rd set of pot treated with $ZnSO_4$+EDTA Solution (100 mg/Kg) (Gupta 2004). The growing plants were measured by using scale every day for one week. Later on they were measured at an interval of 3 days for next 15 days and then at interval of 7 days for 35 days. All plants including were observed for structure and colour of leaves and growth of roots. The data were statistically analyzed by using one way analysis of variance (ANOVA) at $p = 0.05$ for all length except the structure and colour of the leaves. Before statistical analyses were performed, data were tested for normality, if needed. The obtained data had a normal distribution and were not distorted before statistical analysis. All statistical analyses were performed with Statistical Analysis System programs (SAS 2001, Snedecor and Cochran 1982).

RESULTS AND DISCUSSION

The plant growth after seven days in control were 11, 13, and 11 in black gram, mung bean and soy bean respectively while in Ni treated plants were 10, 11 and 11 and Zn treated plant were 11mm in length (Table 1.1) which shows no effect of Ni till seven days of growth. It shows insignificant effects on plant growth till seven days. But after two weeks, in control plants it was 7.2, 8 and 7.1 cm in black gram, mung bean and soy bean respectively while in Ni treated plants were 6.8, 7.2 and 6.3 cm,

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which shows some effect on plant growth. Ni diminishes the plant growth in some extent. In case of Zn treated plant, they were, 7, 6.5 and 6.4 cm in length (Table 1.2). Zn also diminishes the plant growth.

Table 1.1.
Daily Measurement (Length in mm, Mean, SD±0.05)

Day/s	Group C			Group N			Group Z		
	CB	**CM**	**CS**	**NB**	**NM**	**NS**	**ZB**	**Z M**	**ZS**
1st	0	0	0	0	0	0	0	0	0
2nd	0	0	0	0	0	0	0	0	0
3rd	1.5	1.5	0	0	1	0	1	1.5	0
4th	3	3	2.5	3	2.5	2.5	2.5	2.5	2.5
5th	6	7	6	5	4.5	4.5	5	4.5	4.5
6th	8	9.3	8	7	8.5	7	7	6.5	7
7th	11	13	11	10	11	11	11	11	11

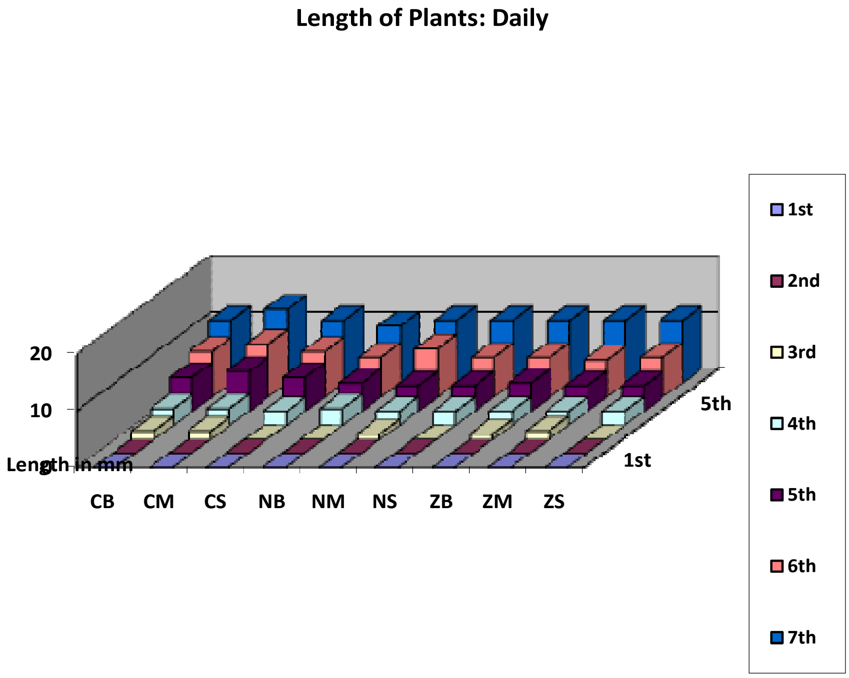

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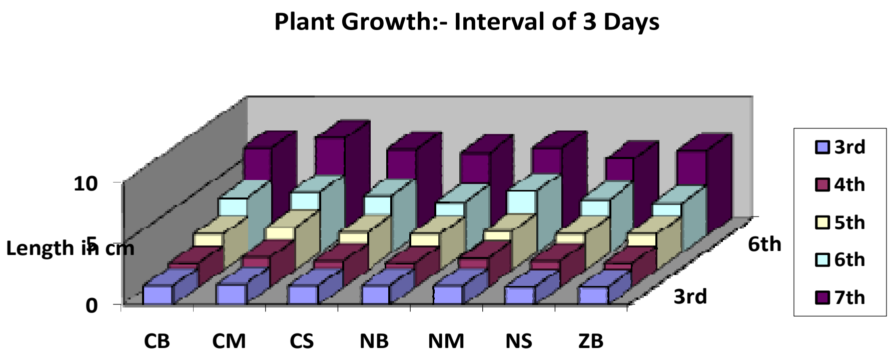
Table 1.2.

Measurement of plant length at interval of 3 days: (Length in cm, Mean, SD ±0.05)

3 Days	Group C			Group N			Group Z		
	CB	CM	CS	NB	NM	NS	ZB	ZM	ZS
3rd	1.6	1.7	1.6	1.6	1.6	1.5	1.5	1.6	1.5
4th	2	2.5	2.2	2	2.4	2.2	2	2.4	2.2
5th	3	3.5	3.1	3	3.2	3	3	2.9	3
6th	4.5	5	4.7	4.2	5.1	4.4	4.1	5.1	4.2
7th	7.2	8	7.1	6.8	7.2	6.3	7	6.5	6.4



Observation after two months of growth of all plants, the heavy metal shows the significant effect on growth of plants. After 8th week, the length of plant were 21.2, 24.1 and 22.3 cm in control of black gram, mung bean and soy bean respectively, While in Ni treated plants, it was 20.8, 22.2 and 18.1 cm and Zn treated plants had 20.1, 15.6, and 20.3 cm correspondingly (Table 1.3). Zn showed greater negative effect on mung bean and Ni showed on soy bean plant.

Table 1.3.

Weekly measurement of plant length: (Length in cm, Mean, SD ±0.05)

Week/s	Group C			Group N			Group Z		
	CB	CM	CS	NB	NM	NS	ZB	ZM	ZS
4th	10.1	10.5	10.2	9.8	8.9	8.4	10.1	7.9	10.2
5th	12.1	13.5	12.9	12.1	13.1	11.2	12.2	10.7	12.5
6th	14.2	16.1	15.1	14.3	16.8	13.2	15.6	12.9	13.8
7th	17.3	20.2	18.4	16.9	19.1	15,3	17.6	14.4	16.3
8th	21.2	24.1	22.3	20.8	22.2	18.1	20.1	15.6	20.3

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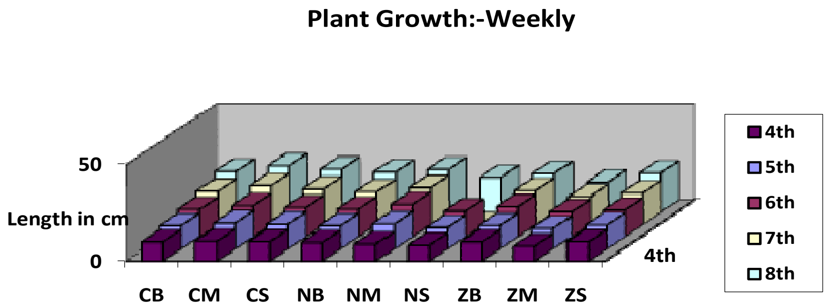

Abbreviation- C= Control, N= Ni (Nickel), Z= Zn (Zinc), B= Black gram, M= Mung bean, S= Soy bean

Plants have developed a range of mechanisms to obtain metals from the soil solution and transport these metals within the plant. The root length of control plants was 6.2, 6.9 and 6.8 cm in black gram, mung bean and Soya bean respectively whereas in experimental, the root length was 5.9, 4.2 and 6.4 cm in black gram, mung bean and soy bean respectively (Table 3.1). The length of control plants after 8 weeks were 21.2, 24.1and 22.3 cm while in Ni treated pots were 20.8, 22.2 and 18.1 cm and in Zn treated pots it was 20.1, 15.6 and 20.3 cm respectively (Table 1.3).

1. *Growth of Roots*

Table 3.1.

Measurement of root length- ***(Length in cm, Mean, SD ±0.05)***

Interval	Group C			Group N			Group Z		
	CB	CM	CS	NB	NM	NS	ZB	ZM	ZS
1st day	0	0	0	0	0	0	0	0	0
7th day	2.0	2.5	2.9	2.0	2.4	2.9	2.0	2.1	2.4
15th day	3.4	4.2	4.5	3.2	3.5	4.0	3.1	2.9	3.9
30th day	5.8	6.5	6.4	5.1	5.3	4.8	4.7	3.9	4.4
60th day	6.2	6.9	6.8	6.0	5.5	5.2	5.9	4.2	6.4

Abbreviation- C= Control, N= Ni (Nickel), Z= Zn (Zinc), B= Black gram, M= Mung bean, S= Soy bean

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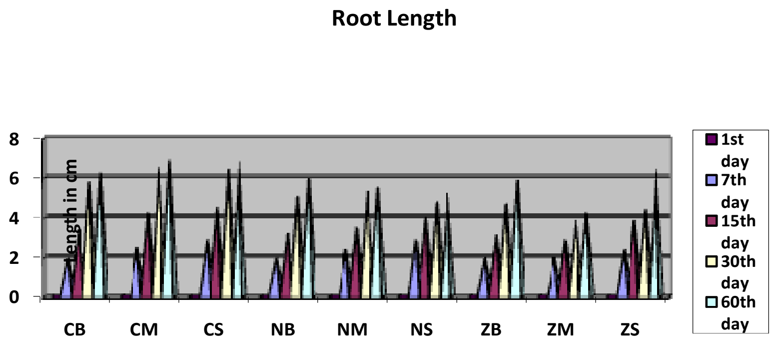

Abbreviation- C= Control, N= Ni (Nickel), Z= Zn (Zinc), B= Black gram, M= Mung bean, S= Soy bean

Ni affects the growth of soy bean plants. The plant length in control was 22.3 cm whereas in experimental was 18.1 cm (Table 1.3). An understanding can be gained of the processes affecting metal uptake and transport by plants. Once within a plant the two major transport mechanisms for metals are via the xylem and phloem. The effects of metals on the rate of movement and composition of the xylem and phloem sap may impact on plant response to metal toxicity. Translocation effects include the relative proportions of metals in roots vs. shoots, potential sites of toxic action of metals and the translocation of other nutrients within the plant. Different plant parts, species and metals appear to elicit different responses and possibly more than one response. However there are certain mechanisms which appear to hold promise as being more widespread than others. Plants tolerant to Ni, and possibly Zn, appear to utilize phytochelatins although this may only be a transport system to sequester metals away in vacuoles. The root and shoot lengths of blackgram gradually decreased with increasing Ni concentrations. This may be due to the accumulation of Ni in plants (Sankar et al., 2006). It may also be induced by the activities of chemical compounds to prevent the re-establishment of the chromosome under normal repairing of some damage. The occurrence of many chromosomal aberrations in the experiment clearly indicates that Ni has a genotoxical effect on root cells. Zinc is transported in the xylem tissues from the roots to the shoots. Heavy metals are extremely toxic elements and they could reduce the mitotic activity and induce many types of chromosomal anomalies (Mukherji et al., 1990; Gupta and Ghosh 1992; Abu Saidah, 1995; Abdel-Azeem and El-Nahas, 1996).

In *Vigna radiata* (mung bean), zinc affects worst on the growth of plant. In *Glycine max* (soy bean), Ni affected the leaves greatly, and yellowing of leaves take place. In *Vigna mungo* (black gram) Zn effected the plant growth. It is clear the fact that Zn not only adversely affect the length of shoot but root also. The root length of control plants was 6.2, 6.9 and 6.8 cm in black gram, mung bean and soya bean, respectively, whereas in experimental plant, the root length was 5.9, 4.2 and 6.4 cm in black gram, mung bean and soy bean, respectively. Ni affects the growth of soya bean plant. The plant length in control 22.3 cm, while in experimental was 18.1 cm. and showed negative effect on the plant growth. There was insignificant effect of Zn and Ni on the structure of leaves, the colour of leaves turn pale yellow in case of Zn treated plants due to chlorosis.

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REFERENCES

1. Abdel-Azeem, E. A., El-Nahas, A. L., (1996). The determined effect of cadmium on seedling growth, mitotic activity and some metabolic changes of rice. J. Faculty of Education, 21: 67-76.
2. Abu Saidah, A. A. A., (1995). Physiological and cytological influence of environmental pollutants on certain Egyptian vegetables Ph.D. Thesis, Faculty of Science, Al-Azhar University, Cairo, Egypt.
3. Gupta, R. S., and Ghosh, P., (1992). Cytological effects of some heavy metals on root tip meristems of Lathyrus sativus. Environ. Ecol., 10: 216-219.
4. Gupta, P.K. (2004). Methods in Environmental Analysis Water, Soil and Air. Updesh Purohil for Agrobios (India), Jodhpur.
5. McBride, M., Sauve, S. and Hendershot, W. (1997). Solubility control of Cu, Zn, Cd and Pb in contaminated soils. European Journal of Soil Science. **48**, 337-346.
6. Mukherji, A., Dhir, H., and Sharma, A., (1990). Interaction between essential elements, zinc and iron and metal pollutants, cadmium and lead on cell division and chromosome aberration, in Vallisneria spiralis L. Cytologia, 55: 405-410
7. Ouzounidou, G. (1994). Root growth and pigment composition in relationship to element uptake in Silene compacta plants treated with copper. Journal of Plant Nutrition. **17**, 933-943.
8. Sankar Ganesh, K., Sundaramoorthy, P., Chidambaram, A.L.A., (2006). Chromium toxicity effect on blackgram, soybean and paddy, Poll. Res., 25(4): 257-261.
9. Snedecor GW, Cochran WG. (1982), Statistical Methods. 7th ed. The Iowa State University Press. Ames, IA.
10. Statistical Analysis Systems. (2001), SAS® User's Guide: Statistics, Version 5 Edition Cary, NC.
11. Whitehead, D.C. (2000). 'Nutrient Elements in Grasslands: Soil-Plant-Animal Relationships.' CABI Publishing, Wallingford.