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Changes in growth, sugar and starch contents in groundnut (*Arachis hypogaea* L.) plants under nickel toxicity

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Abstract

Treatment of groundnut (*Arachis hypogaea* L.) with different concentrations of nickel decreased the growth parameters and biochemical contents. The experiment was conducted at Botanical Garden, Department of Botany, Annamalai University, Tamil Nadu. In the pot culture experiment, groundnut plants were analysed on two different sampling (viz., 15th and 30th) days, in soil amended with various levels of nickel (viz, 10, 30, and 50 mg kg^{-1}). The inner surfaces of pots were lined with a polythene sheet. Each pot containing 3kg of air dried soil. Six seeds were sown in each pot. All pots were watered to field capacity daily. Plants were thinned to a maximum of three per pots, after a week of germination. Nickel at all levels (10,30 and 50mg kg^{-1}) tested, decreased the growth parameters such as, root and shoot length, fresh weight of root and shoot and biochemical constituents such as, sugar and starch contents of groundnut plants compared to untreated plants.

Keywords: Nickel, Growth, Biochemical Contents, groundnut

INTRODUCTION

One of the most important heavy metal in terms of its potential toxicity to plants and animals is nickel (Bazzaz et al., 1974; Gouugh et al., 1979; Kabata-Pendias and Pendias, 1986). It gets to the Earth's surface particularly from metallurgical works in amounts of approximately 12000 tons a year; other important sources are products of fossile fuel combustion and crude oil products. Nickel can contaminate the soil mainly through sewage sludge industrial compost and atmospheric fallout, especially near processing operations (Jagodin et al., 1989; Baran et al., 1997). If larger amounts of nickel are taken up by the plants, the effect is toxic. Phytotoxicity results in chlorosis, weak plant growth, yield depression and may even be accompanied by reduced nutrient uptake and disorders in plant metabolism (Foy et al., 1978; Yang, 1996). Due to the fact that plants take up nickel readily and that nickel is very mobile in plants, there is danger of its excessive accumulation in plant organs and the devaluation of plant products.

The present investigations extent of changes in growth parameters such as, root and shoot length, fresh weight of root and shoot and total leaf area, and biochemical constituents such as, sugar and starch contents in groundnut plants due to nickel toxicity.

MATERIALS AND METHODS

Seed materials

The certified seeds of groundnut were purchased from were purchased from Tamil Nadu Agricultural University, (TNAU) Coimbatore, Seeds with uniform size, colour and weight were chosen for the experimental purpose.

Experimental soil

The soil used in the experiment was sandy loam in nature and the pH of the soil was 7.2. It contains 126 kg available N, 76 kg available P and 98 kg available K/ha, and micro nutrients of 18.32mg available Cu, 190.28mg Fe, 172mg Mn and 20.44mg Zn/kg, nickel was not available in this experimental soil.

Pot culture experiment

The pot culture experiment was conducted at Botanical Garden, Department of Botany, Annamalai University, Tamil Nadu. Surface sterilized groundnut seeds were sown in pots (15 cm in diameter) containing mixture of sandy loam soil in nature, groundnut plants were grown in pots containing untreated soil (Control) and soil mixed with various levels of nickel (viz.,10,30 and 50 mg kg^{-1}). The inner surfaces of pots were lined with a polythene sheet. Each pot contained 3kg of air dried soil. Six seeds were sown in each pot. All pots were watered to field capacity daily. Plants were thinned to a maximum of three per pots, after a week of germination. Each treatment including the control was replicated five times.

Biochemical estimations

The plant samples were collected on 15th and 30th days after sowing. Leaves as treated and control plants were used for the estimation of Sugars content as per (Nelson, 1944) and Starch content as per (Summner and Somers, 1949) method.

RESULTS AND DISCUSSION

Physio-chemical properties of the soil

The pot culture experiments were conducted in Botaniocal Garden, Department of Botany, Government Arts College, Annamalai University. The soil condition was sandy loam in nature and pH, EC, organic carbon and available macro and micro nutrients are given in table -1.

Root and shoot growth

Root and shoot lengths and fresh weight of 15 and 30 days old

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groundnut plants at varying concentrations of nickel are presented in figure-1,2,3 and 4. The root and shoot length and elongation rate are essential for plants exploring for water and mineral nutrients. When compared to the control plants, the length and fresh weight of root and shoot of groundnut plants has been adversely affected due to increase nickel treatment (10, 30 and 50mg kg^{-1}) in the soil in all the sampling days. These results are also in consonance with the observations of (Baccouch et al., 1998) in maize, (Parida et al., 2003) in fenugreek and (Piccini and Malavolta, 1992) in common bean. The inhibitory action of excess of nickel in root and shoot length might be due to reduction in cell division, toxic effect of heavy metals on photosynthesis, respiration and protein synthesis. These obviously contributed to the retardation of normal growth (Mishra and Kar 1974). Kukier and Chaney (2004) and Seregin and Kozhevnikova (2006) also suggested that the morphological and structural effects caused by metal toxicity in plants was due to decrease in root elongation, root tip damage, decrease in root formation, suppression of elongation growth rate of cells, affecting the ultracellular structure of meristematic cells and inhibition of the size of plant cells and inter cellular spaces. Taken up in excess by plants, this non-essential element directly or indirectly inhibits physiological processes such as respiration, photosynthesis, plant–water relationships, loss of cellular turgor, inhibiting the activity of the cell and its enlargement, nitrogen metabolism and mineral nutrition, resulting in poor growth and low biomass (Seregin et al., 2003, Kukier and Chaney, 2004).

Sugar and Starch

Perusal of data in fig-5.6 results on the effect of nickel on sugar and starch contents of leaves of groundnut plants were recorded on 15th and 30th days are presented in figure-5 and 6. The biochemical contents such as sugar and starch contents of groundnut leaves decreased with increase in nickel level (10, 30 and 50mg kg^{-1}) in the soil, in the two sampling days. the higher concentration of nickel in leaf tissue significantly declined sugar level. The above results were in agreement with the findings of Espen et al. (1997) who suggested that increased concentration of nickel in radish seedlings strongly affected reactivation of oxygen uptake and increased the energy change, the mobilization of sugar, phosphor-organic compounds, and inhibited the synthesis of DNA, RNA and protein of soluble and microsomal fractions. Moya et al. (1993) performed experiment on rice plants that were grown 5 or 10 days in a nutrient solution with nickel (0.1 and 0.5 mM). Nickel reduced carbohydrate transport by inhibition of starch conversion into sucrose, and its translocation to the roots resulting into reduced carbohydrate supply for roots and in consequences depressed mitotic activity in root meristems.

CONCLUSION

The results of the present study have shown that nickel treatment was inhibitory to plant growth and biochemical constituents of groundnut plants, when compared to control plants. The loss of these may be due to inhibition of cell division, impairment of PSII activity, directly or indirectly inhibits physiological processes such as respiration, photosynthesis, plant–water relationships, loss of cellular turgor, inhibiting the activity of the cell and its enlargement, changes in the thylakoid organization, resulting in poor growth and low biomass. The decreased sugar and starch contents of groundnut might be due to nickel the strongly affected reactivation of oxygen uptake and increased the energy change, the mobilization of sugar, phosphor-organic compounds, reduced carbohydrate transport by inhibition of starch conversion into sucrose. So there was a consequents reduction in the growth of root and shoot length, fresh weight, sugar and starch contents of plants. The shoot length of nickel treated groundnut plants was higher than the root length.

Table-1 Physio-chemical properties of the experimental soil

Soil type	pH	EC	Moisture content	Organic carbon	Available(kg/h^{-1})			DTPA-TEA extractable (mg kg^{-1})				
					N	P	K	Cu	Fe	Mn	Zn	Ni
Sandy loam	7.2	0.4	22.10	0.58	126	76	96	18.32	190.28	172	20.44	-

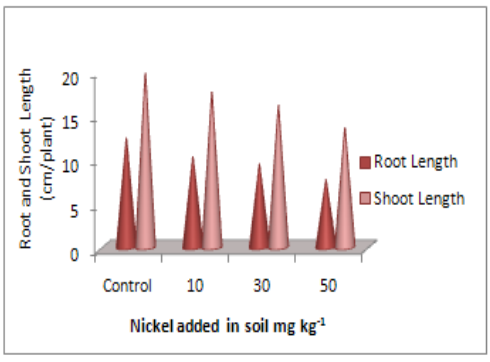

Fig:1 Nickel toxicity in root and shoot length of Groundnut on 15th days

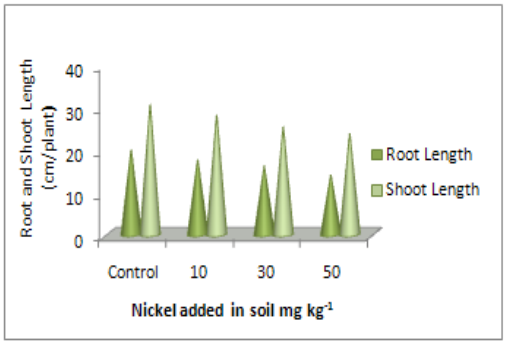

Fig:2 Nickel toxicity in root and shoot length of Groundnut on 30th days

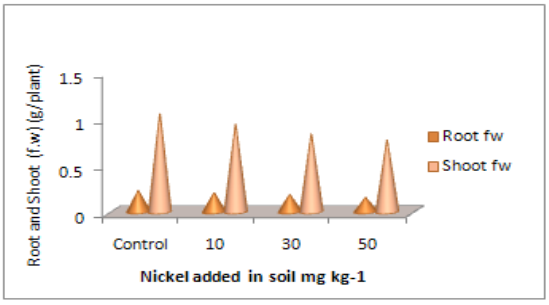

Fig:3 Nickel toxicity in root and shoot f.wt. of Groundnut on 15th days

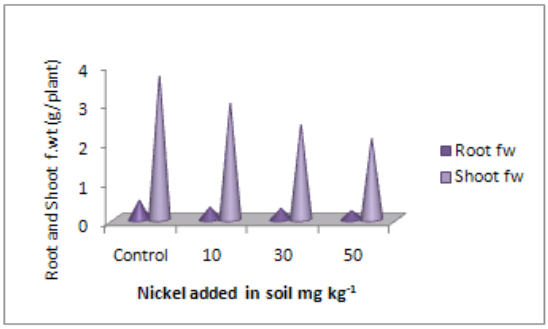

Fig:4 Nickel toxicity in root and shoot f.wt. of Groundnut on 30th days

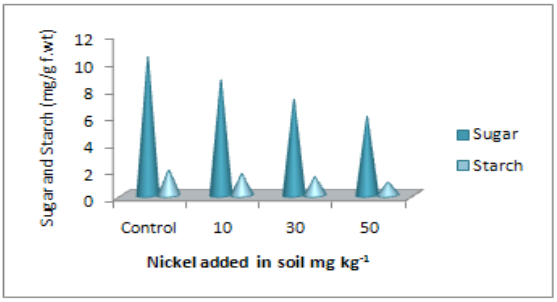

Fig:5 Nickel toxicity in sugar and starch content of Groundnut on 15th days

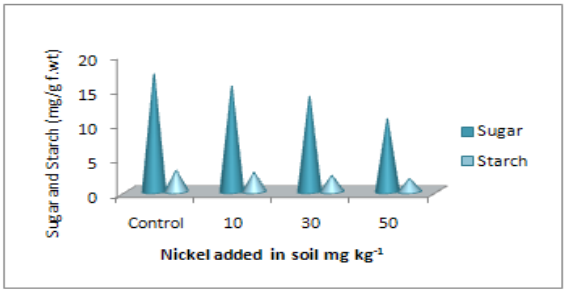

Fig:6 Nickel toxicity in sugar and starch content of Groundnut on 30th days

REFERENCES

Baccouch, S, Chaoui, A. and Ferjani E., 1998. Nickel toxicity: Effects on growth and metabolism of maize. *J. Plant Nutr.,* 21, 577-588.

Baran, S., Flis-Bujak, M., Zukowska, G., Kwiecien, J., Pietrasik, W., Szczepanowska, I. and Zaleski, P., 1997. Forms of nickel in light soil fertilized with sludge (in Polish). Zesz. Probl. PNR, 448a,

Bazzaz, F.A., Carlson, R.W., Rolfe, G.L., 1974. The effect of heavy metals on plants. Environ. Pollut., 7, 241-250.

Espen, L., Pirovano, L. and Sergio, M.C., 1997. Effect of nickel during the early phase of radish (*Raphanus sativus*) seed germination. *Environ. Exp. Bot.,* 38, 187-197.

Foy, C.D., Chaney, R.L., White, M.C., 1978. The physiology of metal toxicity in plants. *Ann. Rev.Physiol.,* 29, 511-519.

Freedman, B. and Hutchinson, T. C., 1980. Pollutant inputs from the atmosphere and accumulations in soils and vegetation near a nickel-copper smelter at Sudbury, Ontario, Canada. *Can. J. Bot.,* 58, 108-132.

Gouugh, L.P., Shacklette, H.T. and Case, A.A., 1979. Element concentrations toxic to plants, animals, and man. US Geol. *Surv. Bull.,* pp.1466- 1480.

Jagodin, B.A., Smirnov, P.M., Peterburgskij, A.V., Asarov, Ch.K., Demin, V.A. and Resetnikova, N.V., 1989. Agrochemistry (in Russian). Agropromizdat, Moscow, pp.639.

Kabata-Pendias, A. and Pendias, H., 1986. Trace Elements in Soils and Plants. CRC Press, *Boca Raton*, pp.315.

Kukier U and Chaney R L 2004. In situ remediation of nickel phytotoxicity for different plant species. *J. Plant Nutr*., 27, 465-495.

Mishra, D. and Kar, M., 1974. Nickel in plant growth and metabolism. Bot. Rev. 40, 395-452.

Moya, J.L., R. Ros and Picazo, I., 1993. Influence of calcium and nickel on growth, net photosynthesis and carbohydrate distribution in rice plants. *Phtosynth.,* 36, 75-80.

Parida, B. K., Chhibba, I .M. and Nayyar, V. K., 2003. Influence of nickel-contaminated soils on fenugreek (*Trigonella corniculata* L.) growth and mineral composition. Sci. Hortic. 98, 113-119.

Piccini, D. F. and Malavolta E 1992. Effect of nickel on two common bean cultivars. J. *Plant Nutr.*, 15, 2343-2350.

Seregin, I. V. and Kozhevnikova, A. D., 2006. Physiological role of nickel and its toxic effects on higher plants. Russ. *J. Plant Physl*., 53, 257-277.

Seregin, I. V., Kozhevnikova, A. D., Kazyumina, E. M and Ivanov, V. B., 2003. Nickel toxicity and distribution in maize roots. *Russ. J. Plant Physl*., 50, 711-717.

Yang, X., 1996. Plant tolerance to nickel nutrients toxicity 2. Nickel effects on influx and transport of mineral nutrients in four plant species. *J. Plant. Nutr.*, 19, 265-279.