Recent Research in Science and Technology 2009, 1(5): 207–210
ISSN: 2076-5061
www.recent-science.com

POLLUTION & ENVIRONMENTAL SCIENCES

STUDIES ON THE EFFECT OF MERCURY ON GERMINATION AND BIOCHEMICAL CHANGES OF GROUND NUT [*ARACHIS HYPOGAEA* (L). VAR. VRI- 1] SEEDLINGS

R. Pugalvendhan[1*] P.S. Sharavanan[2], G. Prabakaran[3]

[1]*Research and Development Centre, Bharathiar University, Coimbatore, Tamilnadu, India*
[2]*Department of Botany, Annamalai University, Annamalai Nagar – 608 002, Tamilnadu, India*
[3]*PG & Research Department of Botany, Govt. Arts College, Dharmapuri – 636 705, Tamilnadu, India*

Abstract

The uptake and accumulation of mercury in various parts of the plants namely stem, root, leaf and seeds showed a gradual decrease with the steady increase in mercury treatment. It can be concluded that the VRI-1 variety of groundnut was proved to be tolerant to mercury. Hence it can it is recommended that the variety VRI-1 can be cultivated in the soils contaminated with mercury and chloralkali plants which use mercury as an electrode in cells for the manufacture of caustic soda and chlorine effluent. This will prevent considerably the extent of damage caused by mercuryon ground nut to a certain extent.

Key Words: *Arachis hypogaea*; Mercury; Germination; Biochemical.

Introduction

Pollution refers to any change in the natural quality of the environment brought about by chemical, physical or biological factors. It is a man-made problem mainly of developed countries. Pollution is an undesirable change in the physical, chemical or biological characteristics of our air, water and land that may harmfully affect human life, industrial progress, living conditions and cultural assets.

Pollution and pollutants increases with arise in population which results into smaller available space as well as into an increase in demands per individual. Water pollution is a state of deviation of pure condition, whereby its normal function and properties affected. The most important effluent discharging industries are tanneries, textiles, distilleries, electroplating units, paper mills, iron and steel industries, fertilizer units, oil refineries, metallurgical units, pesticide and herbicide industries.

The industries are generally categorized as red (high polluting industries) and green (non-polluting industries) by the Ministry of Environment and Forests, Government of India, on the basis of The industries are generally categorised as red (high polluting industries) and green (non-polluting industries) by the Ministry of Environment and Forests, Government of India, on the basis of their potential in polluting the environment (David and Fernandes, 1988). Heavy metals have increases in the environment from industrial waste, agricultural runoff and mining activities. Many of these metals have a direct bearing on various physiological and biochemical process. The sources of illness were finally traced to higher concentrations of organic mercury contained in fish from the bay. Mercury is used in many industrial processes and many instances ultimately finds its way in to the sewage. Mercurial compounds have been known for the fungicides and bacterial properties for many years. The legumes have been under cultivation throughout the World since time immemorial pulses occupy about 13 per cent of the area under cultivation in India. So the present investigation has been carried out to find out the studies on the effect of mercuric on germination and biochemical changes of ground nut [*Arachis hypogaea* (L.)] variety VRI-1 seedings.

Materials and Methods

The present investigation has carried out to find out

* *Corresponding Author, Email: pugalvendhan@gmail.com*

the studies on the effect of mercuric on germination and biochemical changes of ground nut [*Arachis hypogaea* (L.)] variety VRI-1 seedings during germination with control, 10, 25, 50, 75 and 100 mg kg^{-1} soil of mercury treatment. The seeds of ground nut [*Arachis hypogaea* (L.)] variety VRI-1 obtained from Oil Research Station Virudhachallam, Tamil Nadu. The seeds ground nut were grown in pots in untreated soil (Control and in soil to which mercury have been applied 10, 25, 50, 75 and 100 mg kg^{-1} soil.) Vigour index of the seedlings was calculated by using formula proposed by Abdul – Baki and Anderson (1973).

Vigour index = Germination percentage X length of embryonic axis.

Tolerance Index

Tolerance index of the seedling was calculated by using the formula by Turner and Marshal (1972).

The percentage of phytotoxicity

The percentage of phytotoxicity of heavy metal solution was calculated by using the following formula (Chou et al., 1978).

Speed of germination index (SGI)

The speed of germination index was calculated by the following formula given by Carley and Watson (1968)

Fresh weight of root and shoot was taken using single pan balance. The seedind were dried in an air over at 80^0C for 24 hours. Dry weight was recorded using single pan balance.

The biochemical constituents has been carried out by, the following methods.

Biochemical constituents

i. Chlorophyll (Arnon, 1949.)
ii. Carotenoids (Kirk and Allen, 1965)
iii. Total sugar (Nelson, 1944)
iv. Starch (Summner and Somers, 1949)
v. Aminoacids (Moore and Stein, 1948)
vi. Protein (Lowry et al., 1951)

Result and Discussion

The present investigation has been carried out to assess the effect of mercuric on germination and biochemical changes of ground nut [*Arachis hypogaea* (L.)] variety VRI-1 seedings.

Germination studies

The effect of different concentrations of mercury on germination percentage, speed of germination index and vigour index were furnished in Table 1. The germination percentage, speed of germination index and vigour index showed a gradual decline with increase in metal concentration. Maximum values in these parameters were recorded in (viz., 100, 895 and 1320) at control. The minimum values were observed at 100 mg kg^{-1} mercury treatment. (viz., 49, 288 and 494.3).

Table 1. Effect of mercury concentrations on germination parameters of groundnut (*Arachis hypogaea* L.) variety VRI-1 seedlings

Concentration (mg kg^{-1} soil)	Germination Percentage	Speed of Germination Index	Vigor Index
Control	100.00	895	1320.00
10	95.00 (-5.00)	771 (-13.85)	1220.00 (-7.51)
25	86.00 (-14.00)	704 (-21.34)	1095.18 (-17.03)
50	79.00 (21.00)	626 (-30.06)	952.36 (-27.85)
75	70.00 (-30.00)	542 (-39.44)	841.85 (-36.22)
100	49.00 (-51.00)	288 (-67.82)	494.73 (-62.52)

* Percent over control values are given in the parenthesis

Morphometrical parameters

The various growth parameters like root length, shoot length, seedling length, number of lateral roots, root/shoot ratio and tolerance index values were presented in Table 2.

Table 2. Chnges in the morphological parameters of groundnut (*Arachis hypogaea* L.) var. VRI-1 seedlings as affected by mercury treatment

Concentration (mg kg^{-1} soil)	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Number of lateral roots	Root / Shoot ratio	Tolerance Index
Control	6.05	13.20	19.25	10.78	0.458	-
10	5.38 (-11.07)	12.08 (-8.48)	17.46 (-9.30)	9.18 (-14.84)	0.445 (-2.84)	0.922
25	4.91 (-18.84)	11.23 (-14.42)	16.14 (-16.16)	8.15 (-24.40)	0.437 (-4.59)	0.852
50	4.50 (-25.62)	10.46 (-20.68)	14.97 (-22.23)	6.92 (-35.81)	0.430 (-6.11)	0.774
75	4.05 (-33.06)	9.57 (27.50)	13.62 (-29.25)	5.56 (-48.42)	0.423 (-7.64)	0.615
100	3.12 (-48.43)	7.70 (-41.67)	10.82 (-43.79)	3.32 (-70.13)	0.405 (11.57)	0.398

* Percent over control values are given in the parenthesis

The maximum values in root, shoot and seeding length are 6.06, 13.20, and 19.25 cm respectively at control of VRI-1. The minimum values recorded are 3.12, 7.70 and 10.82 cm respectively at 100 mg kg^{-1} concentration. The dry weight root, stem, cotyledons and leaf of groundnut seedlings were expressed in Table 3. The results indicate that the maximum root, stem and leaf dry weights were recorded at control of VRI-1 seedlings 0.044, 0.131 and 0.039 respectively. The minimum dry weight of root, stem, and leaf were observed at 100 mg kg^{-1} mercury treatment (0.020, 0.080 and 0.017). The maximum dry weight of cotyledons of groundnut seedlings was found at control of VRI-1 seedlings 0.049 and the minimum value was observed at 100 mg kg^{-1} mercury treatment ^{s}(0.016).

Photosynthetic pigments

The chlorophyll-a, b, total chlorophyll and carotenoid contents of groundnnut seedlings were presented in Table 4. The maximum amount of chlorophyll a, b, total chlorophyll carotenoid contens (viz., 0.750, 0.693, 1.443 and 0.461) were observed at control of VRI-1 seedlings. The minimum values of chlorophyll a, b, total chlorophyll and carotenoid contents (viz., 0.401, 0.335, 0.736 and 0.273) were recorded at 100 mg kg^{-1} mercury treatment.

Table 3. Dry weight (gm plant^{-1} of groundnut (*Arachis hypogaea* L.) var. VRI 1 seediling under various treatment of mercury

Concentration (mg kg^{-1} soil)	Root	Stem	Cotyledons	Leaf
Control	0.044	0.131	0.049	0.039
10	0.041 (-6.82)	0.116 (-11.45)	0.042 (-14.28)	0.035 (-10.26)
25	0.038 (-13.64)	0.110 (-16.03)	0.036 (-26.53)	0.031 (-20.51)
50	0.034 (-22.73)	0.103 (-21.37)	0.031 (-36.73)	0.028 (-28.21)
75	0.030 (-31.81)	0.098 (-25.19)	0.024 (-51.02)	0.025 (-35.90)
100	0.020 (-54.55)	0.080 (-38.93)	0.016 (-67.34)	0.017 (-56.41)

* Percent over control values are given in the parenthesis

Table 4. Effect of different mercury concentrations on the pigment contents (mg g^{-1} fresh weight) of groundnut (*Arachis hypogaea* L.) var. VRI-1 seediling

Concentration (mg kg^{-1} soil)	Chlorophyll 'a'	Chlorophyll 'b'	Total Chlorophyll	Carotenoid
Control	750	0.693	1.443	0.461
10	0.665 (-11.33)	0.597 (-13.85)	1.262 (-12.54)	0.416 (-9.76)
25	0.627 (-16.40)	0.551 (-20.49)	1.178 (-18.36)	0.394 (-14.53)
50	0.579 (-22.80)	0.503 (-27.42)	1.082 (-25.02)	0.366 (-20.61)
75	0.531 (-29.20)	0.452 (-34.78)	0.983 (-31.88)	0.340 (-26.25)
100	0.401 (-46.53)	0.335 (-51.66)	0.736 (-49.00)	0.273 (40.78)

* Percent over control values are given in the parenthesis

Table 5. Variation in sugar content (mg kg^{-1} fresh weight) of groundnut (*Arachis hypogaea* L.) var. VRI-1 seediling under different treatment of mercury

Concentration (mg kg^{-1} soil)	Root	Stem	Leaf
Control	4.016	4.870	5.637
10	3.609 (-10.13)	4.472 (-8.17)	5.177 (-8.16)
25	3.384 (-15.74)	4.278 (-12.16)	4.948 (-12.22)
50	3.146 (-21.66)	4.033 (-17.19)	4.715 (16.36)
75	2.861 (-28.76)	3.695 (-24.13)	4.374 (-22.41)
100	2.269 (-43.50)	2.902 (-40.41)	3.600 (-36.14)

* Percent over control values are given in the parenthesis

The sugar content of root, stem and leaf of groundnut seedlings were presented in Table 5. The maximum sugar content of root, stem and leaf was found at control viz., 4.016, 4.870 and 5.637 of VRI – 1 variety. The minimum suger content of root, stem and leaf was observed (2.269, 2.902 and 3.600 respectively) at 100 mg kg^{-1} mercury treatment. The starch content of groundnut root, stem and leaf are furnished in Table 6. The results indicated that the maximum starch content of root, stem and leaf (viz., 3.614, 4.383 and 5.073) were observed at control of VRI-1. The minimum starch content of root, stem and leaf (2.042, 2.612 and 3.240) were observed at 100 mg kg^{-1} mercury treatment.

Table 6. Starch content (mg gm^{-1} fresh weight) of groundnut (*Arachis hypogaea* L.) var. VRI-1 seediling as affected by mercury concentrations

Concentration (mg kg^{-1} soil)	Root	Stem	Leaf
Control	3.614	4.383	5.073
10	3.246 (-10.18)	4.025 (-8.17)	4.659 (-8.16)
25	3.046 (-15.72)	3.850 (-12.16)	4.453 (-12.22)
50	2.831 (-21.67)	3.630 (-17.18)	4.244 (-16.34)
75	2.575 (-28.75)	3.326 (-24.12)	3.937 (-22.39)
100	2.042 (-43.50)	2.612 (-40.41)	3.240 (-36.13)

* Percent over control values are given in the parenthesis

Table 7. Effect of mercury on amino acids content (mg kg^{-1} fresh weight) of groundnut (*Arachis hypogaea* L.) var. VRI-1 seediling

Concentration (mg kg^{-1} soil)	Root	Stem	Leaf
Control	7.083	7.985	9.072
10	6.357 (-10.25)	7.252 (-9.18)	8.333 (-8.15)
25	5.869 (-17.13)	6.788 (-14.99)	7.885 (-13.08)
50	5.433 (-23.30)	6.343 (-20.56)	7.393 (-18.51)
75	5.006 (-29.34)	5.793 (-27.45)	6.863 (-24.35)
100	4.101 (-42.10)	4.841 (-39.37)	5.800 (-36.07)

* Percent over control values are given in the parenthesis

Table 8. Changes in protein content (mg kg^{-1} fresh weight) of groundnut (*Arachis hypogaea* L.) var. VRI-1 seediling treated with different concentration of mercury

Concentration (mg kg^{-1} soil)	Root	Stem	Leaf
Control	15.283	21.780	26.562
10	13.612 (-10.93)	19.873 (-8.76)	24.586 (-7.44)
25	12.849 (-15.93)	19.004 (-12.75)	23.465 (-11.66)
50	11.851 (-21.46)	17.664 (-18.90)	22.196 (-16.44)
75	10.790 (-29.40)	16.205 (-25.60)	20.544 (-22.66)
100	8.840 (-42.16)	13.109 (-36.14)	17.501 (-34.11)

* Percent over control values are given in the parenthesis

The maximum amino acids content of root, stem and leaf were observed at control (viz., 7.083, 7.985, 9.072) of VRI-1. The minimum amino acids content of root, stem and leaf of the seedlings were seen at 100 mg kg^{-1} soil mercury treatment (viz, 4.101, 4.841 and 5.800). The leaf possessed higher amino acids content than the stem and root in Table 7. The protein content of root, stem and leaf of groundnut seedlings of VRI-1 were furnished in Table 8. The results indicate that the higher protein content of root, stem and leaf were observed in VRI-1 (viz., 15.283, 21.780, 26.562) at control. The lower protein content of root, stem and leaf were found to be at 100 mg kg^{-1} mercury treatment (8.840, 13.109 and 17.501).

Seedling stage is the most sensitive stage in the life of a plant and hence, more susceptible to physical and chemical adversities. The present study showed a progressive decline in seedling growth with a steady increase in mercury treatment. It is in conformity with the results of Rotheberger and Galitz (1977). The control plant exhibited higher protein content than the treated ones. These results are in agreement with the findings of Levitte (1980).

The uptake and accumulation of mercury in various parts of the plants namely stem, root, leaf and seeds showed a gradual decrease with the steady increase in mercury treatment. It can be concluded that the VRI-1 variety of groundnut was proved to be tolerant to mercury.

Hence it can it is recommended that the variety VRI-1 can be cultivate in the soils contaminated with mercury and chloralkali plants which use mercury as an electrode in cells for the manufacture of caustic soda and chlorine effluents. This will prevent considerably the extent of damage caused by mercury on groundnut to a certain extent.

References

Abdul Baki, A.A. and J.D. Anderson. Vigour determination in soybean seed by multiple criteria. Crop. Sci., 630-633, 1973.

Arnon, Copper enzymes in isolated chloroplasts polyphenol oxidase in Beta vulgaris. Plant Physiol., 24:1-8, 1949.

Carley, H.E. and R.D. Watson. Effect of various aqueous extracts upon seed germination. Bot Gaz, 129:57.62,1968.

Chou, C.H., Y.C. Chang and C.I. Koa, Impact of water pollution on crop growth in Taiwen. Bot Bull. Academi Sinica, 19:107-124, 1978.

David, J.E. and 1. Fernandes. Industries categorized for pollution control. In: Environmental resource Abstracts., 6(4):7, 1988.

Kirk, J.T.O. and R.L. Allen. Dependence of chloroplast pigment synthesis on proteinsynthetic effects of Acitilone. Biochem. Biophys. Res. Cann, 27:523-530, 1965.

Levitte J. Water, relation, salt and other stresses. In: Response of plants to environmental stresses. Vol II. Academic Press, London, 1980.

Lowry. a.H., N.J. Rosebrough., A.L.Farr and Randall. Protein measurement with Folin phenol reagent. Biol. Chem., 193:265-275;1951.

Moore. V.H. Stein. Photometric method for use in the chromatography of amino acids. J.Bio. Chem., 176:367-388. 1948.

Nelson. N.A. photometric adaptation of the smogi's method for determination of reducing suger. Anal. Chem., 31:426-428, 1944.

Rotheberger, S.J. and D.S. Galitz. Effects of Cd, Zn Pb and Mn on germination and growth of selected grasses. Plant physiol., Suppl, 59:123, 1977.

Sarvanan, S., A. Subramani and A.S. Lakshmanachary. Differential tolerance among the cultivars of groundnut to cadmium. Proc. Nat. Conf. Environ. Bio Tech, Bharathidasan University. Abst. 51. 1996.

Summner. J.B. and G.F. Somers, Laboratory experiments in biological chemistry. 2nd ed. Academic press. New York., p.173. 1949.

Turner, R.G. and C. Marshal, Accumulation of zinc by subcellular fraction of root of Agrostis tennuis sibth in relation to zinc tolerance New Physiol., 7:671-676. 1972.