RESEARCH PAPER:

Effect of mercuric chloride on the morphometrical and biochemical changes of *Arachis hypogaea* (L.) varieties VRI-3 and VRI-5

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Asian Journal of Environmental Science, (June, 2011) Vol. 6 No. 1 : 62-65

SUMMARY

The present work deals with the morphometrical and bio-chemical changes on the effect of mercuric chloride on *Arachis hypogaea* varieties VRI-3 and VRI-5.The different concentrations (0,10,25,50,75,and 100 ppm) of mercuric chloride solutions were prepared and used for field studies. Various morphometrical parameters and bio-chemical changes were analysed on the 55th day after sowing. The morphometrical parameters like root length, shoot length, number of leaves, number of root nodules showed a decreasing trend with increase in mercuric chloride concentrations. The minimum value was recorded at 100 ppm in both the varieties (VRI-3 and VRI-5). The maximum values of these parameters were recorded in VRI-3 and minimum values were recorded in VRI-5. The 55th day plants were collected from research field and analysed for the bio-chemical studies at Ecology Research Laboratory, Annamalai University. Reduction in chlorophyll 'a', chlorophyll 'b' and total chlorophyll contents and metabolites like sugars and amino acids were recorded at higher concentrations level. The minimum value of biochemical contents were recorded at 100 ppm in both VRI-3 and VRI-5 varieties. The maximum value of bio-chemical contents recorded at control level both VRI-3 and VRI-5 varieties. The bio-chemical contents for the VRI-3 variety showed maximum values and minimum values were recorded in VRI-5 in all concentrations. From the final conclusion of cultivars, VRI-3 variety was highly tolerant and VRI-5 variety was highly susceptible according to morphometrical and biochemical contents under mercuric chloride treatment.

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Sharvanan, P.S., Thamayanthi, D., Kaleeswari, S. and Ravimycin, T. (2011). Effect of mercuric chloride on the morphometrical and biochemical changes of *Arachis hypogaea* (L.) varieties VRI-3 and VRI-5. *Asian J. Environ. Sci.*, **6**(1): 62-65.

Key words :
Mercuric chloride, Toxic, *Arachis hypogaea*, Chlorophyll, Sugars, Amino acids

Mercury compounds enter natural water during chlor-alakali production, seed dressing exposure to mercury ore (cinnabar) leaching and washing of mercury from soils and rocks and also washing of the atmosphere by rain water. Mostly in the world, mercury is present by the bedrock and deep sea sediment. In Tamil Nadu, many chlor-alkali factory, aluminum factory and mercurial compound factory are situated closed to river Cauvery. The discharge of the effluent of the above factories mixes with river water. The polluted water is used for irrigation for cultivation of land and drinking purposes.

Kurland *et al.* (1960) and Johnels and Westmark (1969) found that chlor-alkali industry is one of the most important sources of mercury pollution to the aquatic environment. High concentration of mercury produces visible injuries in plant like chlorosis, necrosis etc. Mac Lean (1974) reported that the use of mercurial fungicides resulted in the accumulation of mercury on the soil upto 317 mg/g and in plants 36 mg/g.

Stratton *et al.* (1979) studied to effect of mercury on the photosynthesis of *Anabaena inaequalis*. They reported that 2 ppm and 10 ppm mercury concentration required to inhibit photosynthesis. Paivoke (1983) reported that the total nitrogen content decreased with increasing concentrations of lead and arsenate in *Pisum sativum*. All growth inhibitory concentration of copper was found to increase the alkali soluble protein and protease activity in the embryo and endosperm of rice seeds. Zinc was found to alter the chlorophyll contents in groundnut, Paivoke (1983 b), mercury, Rai and Khatonier (1980), mercury and zinc, by Rai *et al.* (1979), mercury by Mhatre and Chaphekar (1984).

Received:
March, 2011
Accepted :
April, 2011

So, the present investigation has been carried out to find the morphometrical and bio-chemical changes on the effect of mercuric chloride on groundnut and find out the tolerant and susceptible variety through, root length, shoot length, number of leaves, root nodules, chlorophyll, sugar and amino acid contents of *Arachis hypogaea.*

MATERIALS AND METHODS

The seeds of *Arachis hypogaea* VRI-3 and VRI-5 were obtained from the Regional Oilseed Research Station, Virudhachalam, Cuddalore District, Tamil Nadu. Mercuric chloride salt was taken for irrigation purpose as the mercury (Hg^{+}) source. 1 gm of mercuric chloride was dissolved in 1000 ml of well water. It is equal to 1000 ppm. 1ml of mercuric chloride solution was make up in to 100 ml of well water it is equal to 1 ppm. The following concentration of mercuric chloride solution was prepared and used for irrigation (control , 10, 25, 50, 75 and 100 ppm). Different concentrations of mercuric chloride solution were poured uniformly in the relevant experimental site while the control plants were irrigated with well water. The irrigation was done thrice in seven days and the irrigation continued for 55 days (life time of the plant 110 days).

The research site was 150 sqm in total area. There was no biotic influence except crop and weeds in the field. Two days before sowing the entire field was irrigated. The plots were prepared in two rows with two meter intervals. Totally 20 plots were prepared and each plot covered 1x1 sq meter area. The groundnut seeds were dipped with a spacing of 15x15cm intervals. The experimental stations were maintained uniformly in all aspects, *i.e.* size, type of variety, colour, and time of sowing and irrigation of mercury solution.

The 55th days, from each treatment plants were taken and they were collected without damage to the root system by washing the roots in running water. The morphometrical characters such as shoot length, root length, number of leaves and root nodules were measured for every sample. Each sample has 3 replicates. The bio-chemical parameters like chlorophyll-a, chlorophyll-b (Arnon, 1949), sugar (Nelson, 1944), amino acids (Moore and Stein, 1948) were also analyzed on the same day.

RESULTS AND DISCUSSION

The root length, shoot length, number of leaves, numbers of root nodules were found to be maximum at control level in both the two varieties. All the morphometrical parameters decreased with increase in the mercuric chloride concentration (Table 1). In similar work, Lipsey (1975) reported that the stunted growth of maize seedlings was due to the effect of methyl mercury hydroxide.

This is inconsonance with the reports of Pavadai *et al.* (2004). Similar results were also observed by Jain (1978) who reported an inhibition in the formation of root nodules of *Phaseolus auroeus* at 25mg cadmium/g soil level. Vesper and Weindensaul (1978) also observed a

Table 1 : Effect of mercury on morphometrical parameters on *Arachis hypogaea* (L.) VRI-3 and VRI-5 varieties (55thDAS plants)

Treatment (ppm)	VRI-3				VRI-5			
	Root length (cm/plant)	Shoot length (cm/plant)	Number of leaves	Number of root nodules	Root length (cm/plant)	Shoot length (cm/plant)	Number of leaves	Number of root nodules
C	16.17	64.57	43.33	23.66	11.40	36.30	26.00	15.66
10	15.23	56.53	41.00	20.66	10.33	28.17	23.33	10.66.
	-5.81	-12.45	-5.37	-12.67	-9.38	-22.39	-10.26	-31.92
20	14.40	48.83	40.00	18.66	9.87	27.00	22.33	9.00
	-10.94	-24.37	-7.68	-21.13	-13.42	-25.61	-14.11	-42.52
30	13.17	45.57	39.00	16.66	9.30	26.07	21.33	7.66
	-17.31	-29.42	-9.99	-29.58	-18.42	-28.18	-17.96	-51.08
40	11.47	41.67	24.33	14.33	8.83	25.03	17.00	6.66
	-29.06	-35.46	-43.84	-39.43	-22.54	-31.04	-34.61	-57.47
50	11.00	26.20	22.33	12.66	8.07	23.93	14.00	5.00
	-31.97	-59.42	-48.46	-46.49	-29.21	-34.07	-46.15	-68.07
100	5.03	20.03	13.66	5.66	4.57	12.20	8.33	2.33
	-68.89	-69.05	-68.47	-76.07	-59.91	-36.39	-67.96	-85.12
Mean	12.38	43.34	31.95	16.04	8.91	25.52	18.90	8.13

Average of three replications
Note: Figures in parentheses represent percent reduction (-) over control

Table 2 : Effect of mercury on chlorophyll content of *Arachis hypogaea* (L.) (mg/g) fresh weight VRI-3 and VRI-5 varieties (55 thDAS plants)

Treatments	VRI-3				VRI-5			
(ppm)	Chl-'a'	Chl-'b'	Total chl	Mean	Chl-'a'	Chl-'b'	Total chl	Mean
C	9.248	7.398	16.646	11.097	4.908	3.928	8.836	5.890
10	9.124	7.283	16.407	10.938	4.556	3.644	8.200	5.466
	-1.34	-1.55	-1.43		-7.17	-7.23	-7.197	
20	7.668	6.168	13.836	9.224	3.996	3.208	7.207	4.802
	-17.08	-16.62	-16.88		-18.58	-18.32	-18.43	
30	5.344	4.295	9.639	6.426	3.980	3.184	7.164	4.776
	-42.21	-41.94	-42.09		-18.90	-18.94	-18.92	
40	5.140	4.112	9.252	6.168	3.528	2.282	6.356	4.237
	-44.42	-44.41	-44.41		-28.11	-28.00	-28.06	
50	4.452	3.565	8.017	5.344	3.168	2.538	5.706	3.804
	-4.452	-3.565	-8.017		-35.45	-35.38	-35.422	
100	2.221	1.776	3.997	2.664	0.932	0.745	1.677	1.118
	-75.38	-75.99	-75.98		-81.01	-81.03	-81.023	
Mean	6.171	4.942	11.113		3.581	2.867	6.44	

Average of three replications
Note- Figures in parenthesis represent percent reduction (-) over control

reduction in the nodule number and nitrogen fixation of soybean due to application of cadmium and nickel.

The pigment contents like chlorophyll 'a', chlorophyll 'b' (Table 2) showed a similar trend. This is in accordance with the earlier findings of Hampp *et al.* (1976) who reported that cadmium and zinc inhibited the CO_2 fixation of isolated chloroplasts of *Spinacia oleraceae* .Various heavy metals were found to alter the chlorophyll contents. Lead and arsenate were found to alter the chlorophyll contents in groundnut (Paivoke, 1983 a), mercury (Raimycin, 1995). The same trend was reported by Vijayarengan and Dhanavel (2005), the increasing nickel level in the soil decreased significantly the chlorophyll 'a' and chlorophyll 'b' contents of blackgram cultivars. The metabolites like total sugar and amino acids decreased with increase of mercury concentration Table 3. Paivoke (1983 a and b) also reported that the total nitrogen content decreased with increasing concentration of lead and

Table 3 : Toxic effect of mercury on total sugars and amino acids (mg/g) of *Arachis hypogaea* (L.) varieties VRI-3 and VRI-5

Treatments (ppm)	VRI-3 Sugars		VRI-5 Sugars		VRI-3 Amino acids		VRI-5 Amino acids	
	Root	Shoot	Root	Shoot	Root	Shoot	Root	Shoot
Control	14.315	26.220	9.802	20.788	15.530	17.859	10. 672	14.796
10	13.232	23.437	9.388	18.394	14.273	15.769	10.423	13.103
	–7.56	-10.62	-4.22	-11.51	-8.09	-11.70	-2.33	-11.44
20	13.127	21.464	8.845	17.715	13.121	14.543	9.262	12.273
	– 8.29	-18.14	-9.76	-14.77	-15.51	-18.56	-13.21	-17.05
30	11.305	19.716	7.201	15.650	12.372	13.776	8.631	10.392
	– 21.02	-20.99	-26.53	-24.71	-20.33	-22.86	-19.12	-29.76
40	11.226	19.594	7.002	15.405	11.273	12.255	7.721	9.252
	– 21.57	-25.27	-28.56	-25.88	-27.41	-31.37	-27.65	-37.46
50	9.472	18.404	5.724	14.345	10.372	11.255	6.342	8.879
	– 33.83	-29.81	-41.60	-30.98	-33.21	-36.97	-40.57	-39.99
100	5.277	9.615	3.392	6.343	5.331	6.101	3.251	4.133
	– 63.13	-63.32	-66.41	-69.48	-65.67	-65.83	-69.53	-72.06
Mean	11.136	19.922	7.322	15.520	11.75	13.07	8.043	10.404

Average of the replications
Note: Figures in parenthesis represent percent reduction (-) over control

arsenic in *Pisum sativum* and the same author also found that the concentration dependent decreased in total nitrogen content in pea plants due to zinc.

The similar type of work was done by Pavadai and Dhanavel (2004) in zinc and Sharavanan *et al.* (2007) in cadmium. The growth parameters and biochemical contents like chlorophyll, sugar, protein showed decreasing trend with increase in mercury chloride concentrations.

However, VRI-3 variety showed that maximum values were recorded at control levels in all concentration level including 100 ppm and minimum values were recorded in VRI-5 variety at control level in all concentration levels including 100 ppm. From the final observations of cultivars, VRI-3 variety was highly tolerant and VRI-5 variety was highly susceptible according to morphometric and bio-chemical contents under mercuric chloride treatment. Hence, VRI-3 variety was recommended for the mercuric pollution area to cultivars the farmers.

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