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Phytotoxic effect of zinc on different varities of ground nut *Arachis hypogea (*L.)

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Abstract
The present investigation carry out the effect of different concentration of zinc(zn) on the morphological parameter of different varieties of ground nut plant. The ground nut plants were raised in plastic cup containing the soil (1kg) with different concentrations of zinc (zn) (control, 2.5,5,7.5,10 mg kg^{-1} soil). Three replicates were maintained for each level. The plant samples were collected at 7th DAS for the measurement of different growth parameters. The selection of morphological parameters such as root length, shoot length, number of leaves, fresh and dry weights vigour index, tolerance index and phytotoxity of ground nut were determined for all the sampling days. All the parameters increased in control treatments, 10 mg kg^{-1} zinc (zn) treatment decreased of ground nut.

Keywords: zinc (zn), morphological parameter, vigour index, tolerance index and phytotoxicity

Introduction
Pollution may be defined as 'an undesirable change in the physical, chemical or biological characteristics of our air, water and land that may or will harmfully, affect human life, the lives of the desirable species, our industrial processes, living conditions and cultural assets, or that may or will waste or deteriorate our raw materials. Pollution is mostly man made, but it can also be natural. Natural pollution is caused by volcanic eruptions, emission of natural gases, soil erosion, ultraviolet rays, cosmic rays etc.
Heavy metal (HM) contamination of the environment has increased to levels that are harmful for living organisms, mainly because of anthropogenic activities. HMs are non-degradable pollutants, and, thus, they persist indefinitely in diverse environmental matrices. Among HMs, zinc (Zn) can be included; it has an atomic number of 30 and atomic weight of 65.38, it is the 24rd most abundant element on earth, and it is an essential trace element for all living beings, including plants. Zinc is a constituent of many proteins, it is also an enzyme cofactor and it is fundamental for optimum plant growth and development (Broadley *et al.*, 2007) [1]. However, at high concentrations in the soil, Zn is phytotoxic, and plants that accumulate it through root absorption or deposition, pose health risks to consumers (Bolan *et al.*, 2014) [3]. Therefore, remediation of HM polluted soils is imperative and necessary to reduce their impact on plants, ecosystems, landscape, soil microbial biodiversity and human health.
Pollutants can be naturally occurring substances or energies, but they are considered contaminants when in excess of natural levels. Any use of natural resources at a rate higher than nature's capacity to restore itself can result in pollution of air, water, and land. (Iyyanki V. Muralikrishna *et al* 2017) [2].

Materials and Methods
1. Plastic cup Experiments
The seeds ground nut (CO-1, CO-2, CO-6, COGn-4, VRI-2, VRI-3, TMV-7, TMV-13, TMV-14, JL-24) was obtained from Tamilnadu Agricultural University (TNAU), Coimbatore and Tamilnadu. The uniform seeds are selected for the experimental purpose. Source of zinc (zinc chloride ($ZnCl_2$) stock solution prepared by dissolving the molecular weight of (Zn) and different concentrations *viz.*, (Control 2.5,5,7.5 and 10 mg kg^{-1} soil) of (Zn) the solution were prepared freshly at the time of experiments. The plastic cups were filed with 1 Kg of garden soil, selected ground nut seeds were sown in the plastic cup and one set of plastic cup irrigated with normal tap water was maintained as the control.

2. Shoot length and root length (cm/seedling)
Five plants from each plastic cup were randomly selected for 7th days of seedlings recorded the shoot length and root length of experimental plants. They were measured by using centimeter scale (Cm).

3. Fresh weight and dry weight (g/seedling)
Five plant samples were randomly selected at 7th day seedlings. Their fresh weight was taken by using an electrical single pan balance. The fresh plant materials were kept in a hot air over at 80°C for 24 hr and then their dry weight were also determined.

Vigour index
Vigour index of the seedlings was calculated by using the formula proposed by Abdul-Baki and Anderson (1973) [4].

Vigour index = Germination percentage × Length of seedling

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

$$\text{Tolerance index} = \frac{\text{Mean length of longest root in treatment}}{\text{Mean length of longest root in control}}$$

Percentage of phytotoxicity
The percentage of phytotoxicity of effluent was calculated by using the formula proposed by Chou *et al.* (1978).

$$\text{Percentage of phytotoxicity} = \frac{\text{Radical length of control - Radical length of test}}{\text{Radical length of control}} \times 100$$

Result
Germination percentage (7th day)
The effect of seed germination percentage of different varieties of CO-1, CO-2, CO-6, COGn-4, VRI-2, VRI-3, TMV-7, TMV-13, TMV-14,JL-24 ground nut with the treatment of zinc were presented in table 1.The Highest germination percentage is recorded were 98,90,82,72 and 61% for the varieties CO-1,CO-2,CO-6,COGn-4,VRI-2,VRI-3,TMV-7,TMV-13,TMV-14,JL-24 respectively. All the varieties exhibited highest percentage of germination at control (without treatment) the minimum germination percentage was observed in all the varieties at 10 mg zinc concentration.
Among the varieties COGn-4 were more maximum seed germination were observed as compared to other varieties in all the treatment concentrations.
The maximum vigour index (2112.0) and tolerance index (1.64) and also lowest percentage of phytotoxicity (1.994) were recorded in the seedlings treated with 2.5mg concentration of zinc. The lowest vigour index (1.72) and tolerance index (0.21) and also highest percentage of phytotoxicity (8.325) were recorded in the seedlings treated with 10 mg concentration of zinc.

Shoot length
The maximum shoot length of recorded were, and 14.2 cm for the varieties COGn-4 respectively. All the varieties exhibited maximum shoot length at control the minimum germination percentage was observed (3.2) in co-1 varieties at 10mg zinc concentration

Root length
The highest Root length of recorded were, and (6.1) for the varieties CO-1, CO-2,CO-6,COGn-4,VRI-2,VRI-3,TMV-7,TMV-13,TMV-14,JL-24 respectively. All the varieties exhibited highest Root length at control the minimum Root length was observed in all the varieties at 10 mg zinc treatment.

No of leaf
The maximum No of leaf recorded were, and 2 for the varieties CO-1, CO-2, CO-6, COGn-4, VRI-2, VRI-3,TMV-7,TMV-13,TMV-14,JL-24 respectively. the minimum No of leaf was observed in all the varieties at 10 mg zinc concentration.

Fresh weight
The fresh weight of seedlings of all the varieties treated with different concentration of zinc The maximum fresh weight of ground nut seedlings was recorded at control. The minimum seedlings fresh weight was observed at 10 mg zinc concentration in all the varieties. The highest value was observed in the control of (COGn-4). the lowest value was noticed at 10 mg(1.7)co-1 varieties.

Dry weight
The Dry weight of seedlings of all the varieties treated with different concentration of zinc are represented in table

The highest Dry weight of ground nut seedlings was recorded at control. The lowest seedlings Dry weight was observed at 10 mg zinc concentration in all the varieties. The highest value was observed in the control of (COGn-4) the lowest value was noticed at 10 mg (0.41) co-1

Table 1: Influence of Zinc on seed germination percentage of Groundnut (*Arachis hypogea)* On 7th DAS

Zinc Chloride treatment	Germination Percentage (%)									
	Co-1	**Co-2**	**Co6**	**CoGn-4**	**VRI-2**	**VRI-3**	**TMV-7**	**TMV13**	**TMV-14**	**JL-24**
Control	92±2.76	92±2.76	95 ±2.85	98 ±2.94	95 ±2.85	93±2.79	94±2.82	97±2.91	96±2.88	91±2.73
2.5mg kg^{-1}	85±2.55	88±2.64	84±2.52	90 ±2.7	83±2.49	84±2.52	81±2.42	87±2.61	82±2.46	80±2.4
5mg kg^{-1}	70±2.1	75±2.25	80 ±2.4	82±2.46	78 ±2.34	76 ±2.28	73±2.19	72±2.16	71±2.13	69±2.07
7.5mg kg-^{1}	58±1.74	66±1.98	72 ±2.22	74 ±2.16	71 ±2.13	70 ±2.1	71±2.13	68±2.04	67±2.01	52±1.56
10mg kg^{-1}	30±0.9	32±0.96	61 ±1.83	61±1.83	62 ±1.86	60±1.8	34±1.02	35±1.05	32±0.96	31±0.93

Table 2: Influence of Zinc on Shoot Length of Groundnut (*Arachis hypogea. L*) On 7th DAS

Zinc Chloride treatment	Shoot length (c.m)									
	Co-1	**Co-2**	**Co6**	**CoGn-4**	**VRI-2**	**VRI-3**	**TMV-7**	**TMV13**	**TMV-14**	**JL-24**
Control	12.0±0.36	12.2±0.366	11.6±0.348	14.2±0.426	13.1±0.393	12.8±0.384	13.2±0.39	12.2±0.35	13.1±0.37	13.4±0.402
2.5mg kg^{-1}	10.5±0.315	11.3±0.339	9.8±0.294	13.8±0.414	12.6±0.378	11.2±0.336	12.5±0.37	11.2±0.33	12.1±0.36	12.1±0.363
5mg kg^{-1}	8.0±0.24	9.5±0.285	7.4±0.222	10.2±0.306	9.6±0.288	9.4±0.282	9.1±0.36	10.1±0.32	9.1±0.30	10.0±0.3
7.5mg kg-^{1}	6.3±0.189	7.2±0.216	6.1±0.183	9.0 ±0.27	7.2±0.216	6.8±0.204	9.2±0.36	9.0±0.26	8.1±0.21	8.4±0.252
10mg kg^{-1}	3.2±0.096	4.6±0.138	3.6±0.108	7.5 ±0.225	5.3±0.159	4.5±0.135	6.7±0.26	5.83±0.17	6.4±0.21	5.2±0.156

Table 3: Influence of Zinc on Root length of Groundnut (*Arachis hypogea. L)* On 7th DAS

Zinc Chloride treatment	Root length (c.m)									
	Co-1	**Co-2**	**Co6**	**CoGn-4**	**VRI-2**	**VRI-3**	**TMV-7**	**TMV13**	**TMV-14**	**JL-24**
Control	3.8±0.114	4.5±0.135	4.3±0.129	6.1±0.183	4.3±0.12	4.6±0.13	4.8±0.14	4.3±0.129	4.3±0.129	4.7±0.141
2.5mg kg^{-1}	3.2±0.096	3.4±0.102	3.4±0.102	5.2±0.156	3.2±0.14	3.4±0.12	4.4±0.13	3.7±0.111	3.2±0.096	3.6±0.108
5mg kg^{-1}	2.4±0.072	3.1±0.093	2.8±0.084	4.0 ±0.12	3.7±0.11	2.4±0.10	3.38±0.11	3.0±0.09	3.0±0.09	3.0±0.09
7.5mg kg-^{1}	2.0±0.06	2.5±0.075	1.6±0.048	4.0 ±0.12	3.8±0.08	3.2±0.11	3.1±0.09	2.6±0.078	3.0±0.09	2.7±0.081
10mg kg^{-1}	1.6±0.048	1.8±0.054	0.8±0.024	3.4±0.102	3.1±0.09	3.1±0.07	2.63±0.07	2.0 ±0.06	2.1±0.063	2.3±0.069

Table 4: Influence of Zinc on Fresh Weight of Groundnut (*Arachis hypogea. L)* On 7th DAS

Zinc Chloride treatment	Fresh weight (g.fr.wt)									
	Co-1	**Co-2**	**Co6**	**CoGn-4**	**VRI-2**	**VRI-3**	**TMV-7**	**TMV13**	**TMV-14**	**JL-24**
Control	8.2±0.252	8.4±0.2	8.6±0.258	10.7±0.321	8.4±0.17	7.9±0.237	8.1±0.31	8.5±0.255	8.0±0.24	8.6±0.258
2.5mg kg^{-1}	5.7±0.171	6.2±0.10	7.2±0.216	8.1±0.243	6.7±0.1	5.1±0.153	7.2±0.23	5.7±0.171	5.2±0.156	6.8±0.204
5mg kg^{-1}	4.2±0.126	5.2±0.11	6.4±0.192	7.2 ±0.216	5.2±0.14	4.0±0.12	5.3±0.14	4.8±0.144	4.2±0.126	5.1±0.153
7.5mg kg-^{1}	3.0±0.09	4.3±0.09	5.2±0.156	5.4 ±0.162	4.5±0.13	2.5±0.075	4.1±0.13	4.1±0.123	3.0±0.09	4.2±0.126
10mg kg^{-1}	1.7±0.051	2.9±0.8	2.8±0.084	3.0 ±0.09	2.9±0.7	2.1±0.063	3.1±0.12	3.4±0.102	2.4±0.072	3.0±0.09

Table 5: Influence of Zinc on Dry Weight of Groundnut (*Arachis hypogea. L)* On 7th DAS

Zinc Chloride treatment	Dry weight (g.dr.wt)									
	Co-1	**Co-2**	**Co6**	**CoGn-4**	**VRI-2**	**VRI-3**	**TMV7**	**TMV13**	**TMV-14**	**JL-24**
Control	3.00±0.09	3.19±0.095	3.15±0.094	4.90±0.147	3.18±0.41	3.24±0.097	3.14±0.09	3.08±0.0924	3.16±0.09	3.13±0.0939
2.5mg kg^{-1}	2.18±0.0654	2.68±0.080	2.58±0.077	3.77±0.113	3.75±0.11	2.74±0.082	2.72±0.81	2.23±0.0669	3.14±0.094	2.40±0.072
5mg kg^{-1}	0.94±0.0282	1.40±0.042	1.05±0.031	2.28±0.068	1.53±0.04	1.51±0.045	1.42±0.42	0.99±0.029	2.23±0.066	1.02±0.0306
7.5mg kg-^{1}	0.74±0.0222	0.97±0.029	0.92±0.027	1.23±0.036	0.95±0.28	1.00±0.03	0.83±0.26	0.76±0.0228	0.93±0.27	0.80±0.024
10mg kg^{-1}	0.41±0.0123	0.61±0.018	0.59±0.017	0.69±0.020	0.62±0.18	0.69±0.020	0.65±0.19	0.52±0.015	0.53±0.015	0.52±0.0156

Table 6: Influence of Zinc on Number of Leaves Groundnut (*Arachis hypogea. L)* On 7th DAS

Zinc Chloride treatment	Number of Leaves (No)									
	Co-1	**Co-2**	**Co6**	**CoGn-4**	**VRI-2**	**VRI-3**	**TMV-7**	**TMV13**	**TMV-14**	**JL-24**
Control	2 ±0.06	4±0.12	4±0.12	5±0.15	4±0.12	4±0.12	4±0.12	4±0.12	4±0.12	4±0.12
2.5mg kg^{-1}	2±0.06	4±0.12	4±0.12	5±0.15	4±0.12	4±0.12	4±0.12	4±0.12	4±0.12	4±0.12
5mg kg^{-1}	2±0.06	4±0.12	4±0.12	5±0.15	4±0.12	4±0.12	4±0.12	4±0.12	4±0.12	4±0.12
7.5mg kg^{1}	2±0.06	4±0.12	4±0.12	5±0.15	4±0.12	4±0.12	4±0.12	4±0.12	4±0.12	4±0.12
10mg kg^{-1}	2±0.06	4±0.12	3±0.9	5±0.15	2±0.06	4±0.12	2±0.06	4±0.12	4±0.12	3±0.9

Table 7: Influence of Zinc on Vigour index of Groundnut (*Arachis hypogea. L)* On 7th DAS

Zinc treatment	Vigour index									
	Co-1	**Co-2**	**Co6**	**CoGn-4**	**VRI-2**	**VRI-3**	**TMV-7**	**TMV13**	**TMV-14**	**JL-24**
Control	1698±50.94	1976±59.28	1982±59.46	2112±63.36	1807±54.21	1981±59.43	1993±59.79	1760±52.8	1934±58.02	1990±59.7
2.5mg kg^{-1}	1587±47.61	1648±49.44	1670±50.1	1724±51.72	1629±48.87	1642±49.26	1653±49.59	1602±48.06	1610±48.3	1692±50.76
5mg kg^{-1}	892±26.76	992±29.76	1105±33.15	1310±39.3	1052±31.56	1015±30.45	1113±33.39	983±29.49	1096±32.88	1002±30.06
7.5mg kg-^{1}	712±21.36	823±24.69	810±24.3	920±27.6	845±25.35	857±25.71	835±25.05	809±24.27	729±21.87	856±25.68
10mg kg^{-1}	301±9.03	349±10.47	402±12.06	482±14.46	370±11.1	389±11.67	352±10.56	320±9.6	486±14.58	390±11.7

Table 8: Influence of Zinc on Tolerance index of Groundnut (*Arachis hypogea. L)* On 7th DAS

Zinc Chloride treatment	Tolerance index									
	Co-1	**Co-2**	**Co6**	**CoGn-4**	**VRI-2**	**VRI-3**	**TMV-7**	**TMV13**	**TMV-14**	**JL-24**
Control	-	-	-	-	-	-	-	-	-	-
2.5mg kg^{-1}	1.182±0.035	1.119±0.033	1.132±0.033	1.647±0.049	1.228±0.036	1.235±0.037	1.3i3±0.039	1.389±0.041	1.214±0.036	1.326±0.039
5mg kg^{-1}	0.603±0.018	0.621±0.018	0.665±0.019	0.952±0.028	0.708±0.021	0.650±0.019	0.667±0.020	0.692±0.020	0.637±0.019	0.640±0.019
7.5mg kg^{1}	0.311±0.009	0.345±0.010	0.354±0.010	0.622±0.018	0.374±0.011	0.329±0.009	0.362±0.010	0.330±0.009	0.325±0.009	0.328±0.009
10mg kg^{-1}	0.202±0.006	0.214±0.006	0.262±0.007	0.330±0.009	0.280±0.008	0.215±0.006	0.324±0.009	0.234±0.007	0.253±0.007	0.214±0.006

Table 9: Influence of Zinc on Phytotoxicit of Groundnut (*Arachis hypogea. L)* On 7th DAS

Zinc Chloride treatment	Phytotoxicity									
	Co-1	**Co-2**	**Co6**	**CoGn-4**	**VRI-2**	**VRI-3**	**TMV-7**	**TMV13**	**TMV-14**	**JL-24**
Control	-	-	-	-	-	-	-	-	-	-
2.5mg kg^{-1}	1.994±0.059	1.849±0.055	1.983±0.059	1.570±0.047	1.980±0.0594	1.722±0.051	1.885±0.56	1.725±0.05	1.823±0.054	1.873±0.056
5mg kg^{-1}	4.408±0.132	3.609±0.108	3.663±0.109	3.104±0.093	4.003±0.120	3.890±0.116	3.703±0.111	3.665±0.109	3.530±0.105	3.540±0.106
7.5mg kg^{1}	6.789±0.203	6.440±0.193	5.983±0.179	4.842±0.145	5.982±0.179	6.503±0.195	5.972±0.179	5.472±0.164	5.541±0.166	5.528±0.165
10mg kg^{-1}	8.325±0.249	8.102±0.243	8.003±0.240	5.910±0.177	7.490±0.224	8.218±0.246	8.352±0.250	7.356±0.220	7.132±0.213	7.112±0.213

Discussion

The effect of Zn and B on plant height of groundnut is depicted in. The plant height of groundnut increased with the age of the crop and attained maximum at harvest. At vegetative stage of the crop the treatments did not show any significant differences on plant height. Although, there was significant differences among the treatment in plant height at flowering and harvesting stages. The height of the plant varied from 28.3 – 35.6 cm and 31.3 - 41.5 cm at flowering and harvesting period respectively among the treatments. Combined application of Zn and

B significantly enhanced the height of the plant being the maximum under Z2B2 at both flowering and harvesting followed by Z2B1. Z2B2 recorded maximum 39% increase in plant height at flowering stage followed by Z2B1 (32%). also observed the increased vegetative growth of groundnut with foliar applications of Zn and B. Though, the sole application of B did not have any effect on plant height during the entire growth phase. The lowest value of plant height was noted under control (Z0B0) throughout the growth stages. Das (1992) [9].

Zinc though an essential element for plant growth, showed toxicity symptoms at higher concentrations inhibiting root growth (bradshaw *et al* 1990) [19] Zinc toxicity was marked in root system particularly in root blunt, thickening and caused restraint on both cell division and cell elongation (wainwright *et al* 1976) [10].

As seen in dry weight of plant had consecutively increased from 15 DAS to harvest. At harvest highest dry weight (26.47 g/plant) was recorded with application of 50 kg Phosphorus/ha + 30 kg Zinc/ha which was significantly superior over rest of the treatments except with the application of 50 kg Phosphorus/ha + 25 kg Zinc/ha (25.94 g/plant) and 40 kg Phosphorus/ha + 30 kg Zinc/ha (23.02 g/plant). Increasing phosphorus rates increased dry weight/plant.

Kausale *et al*. (2009) [11] reported that the application of 50 kg Phosphorus/ha significantly increased plant dry weight (29.33 g) over 30 kg Phosphorus/ha. The increase in dry matter production with phosphorus might be due to better nodulation of crop owing to better availability of phosphorus. The improvement in nodulation might have resulted in higher amount of nitrogen fixation and their by better vegetative growth and dry matter production. Zinc plays as an activator of several enzymes in plants and it is directly involved in the biosynthesis of growth substances such as auxin thereby producing more plant cells and enhanced dry matter (Christopher *et al.,* 2019)

To evaluate meaningful physiological and biochemical effects of toxicity, one must know the metals which are phytotoxic in nature and interactions with other metals [30]. Before starting a phytotoxicity experiment one should be fully aware of the movement of the metal including its absorption and translocation in the plant system. Availability of metal in the soil depends on soil adsorption strength as well as plant effectors such as root exudates for metal chelation or reduction. Metal phytotoxicity can result only if metals can move from the soil to root systems (foy.C.D *ed.al* 1978) [12]. Phytotoxicity levels of zinc in different crop plants were reported by many workers (chardonnens A.N *et.al* 1999) [7]. The most significant phytotoxicity symptoms were stunting of growth, chlorosis and reduction in biomass yield. The phytotoxicity caused by a wide variety of metals has been well documented; however, models designed to quantify the relationship between exposure to metal ions and progressive yield losses are lacking (Taylor. G.J *et al*.1991) [13].

However, decline in water absorption and transport along with water stress tolerance (Barcelo *et al.,* 1988) [14] resulting in lower plant growth and development. Moreover, reduction of germination under Cr (VI) stress, is probably due to increase of protease activity and decrease in a- and b- amylase activities (Parmar *et al.,* 2002) [15]. The suppression of germination rate was only recorded at higher Cr concentration. This perhaps due to the disruption in seed coat permeability (Hou *et al.,* 2014) [16].

The reduction in growth of shoot and root might be due to reduction in cell division, deleterious effect of Hg (II) on photosynthesis, respiration and protein synthesis (Vijayaragavan *et al.,* 2011) [17]. Moreover, it may be suggested that the suppression in root growth may be due to inhibition of root cell division or elongation, or to the extension of the cell cycle (Ryan *et al.,* 1997) [18].

This decrease indicates that the chlorophyll synthesis system and chlorophyllase activity were affected by the exposure to high cadmium concentrations as suggested by (Assche and Clijsters, 1990) [19] The present study concluded that the seed and seedling of black gram has potential to counteract the deleterious effects of cadmium metal in soil.

Conclution

The present investigation is cantered on the detection of response of groundnut when subjected to zinc effluent irrigation under the backdrop of an ecological experiment in control vicinity. Systematic experiment including varietal screening germination study where conducted and inferences where recorded.

The germination study was conducted on 10 varieties of groundnut such as CO-1,CO-2,CO-6,COGn-4,VRI-2,VRI-3,TMV-7,TMV-13,TMV-14 and JL-24 treated with different concentration of zinc taking cognizance of the parameters such as germination percentage, shoot length, root length, fresh weight, dry weight, vigour index, tolerance index,phytexoxity found to be at an increase in trend at 2.5mg concentration of zinc contrasting sharply with the situation in maximum concentration. Among the ten varieties treated the variety CoGn-4 is established as tolerant and on the basic of the appreciation trend observed with reference for the morphological parameter hence CoGn-4 variety was singled out and the subjected to our the research.

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