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Effects of Indole-3-Acetic Acid on Germination in Lead Polluted Petri Dish of *Citrullus lanatus* (Thunberg) Matsumura and Nakai, Cucurbitaceae

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Abstract – Watermelon, *Citrullus lanatus* (Thunberg) Matsumura and Nakai is a tropical fruit vegetable. Indole-3-acetic acid (IAA) is a popular phytohormone while lead (Pb) is a common environmental pollutant in urban and sub-urban centers. *C. lanatus* were obtained from Benin City with a view to study the effects of IAA on their germination in Pb polluted environment. Germination percentage without IAA and Pb treatment in petri dish was significant after ten days. Hastened germination was observed when IAA and lead were used. About 100 % germination was recorded after seven days. This suggests that water melon seeds can initiate growth even in lead polluted environment. Optimum level of 5 ppm IAA with the different levels of lead treatments may be recommended. Most important was that higher concentrations of Pb in the control (without IAA) did not inhibit seedling shoot nor root growth. Longest seedling shoot length (cm) was 10.33 ± 1.24 and 12.13 ± 2.06 on the seventh and eighth day respectively with the combined treatment levels of 1 ppm IAA and 15 ppm Pb. On the ninth day, 15.27 ± 0.96 was obtained from 1 ppm IAA and 20 ppm Pb. Longest seedling root length (cm) values were recorded from the combined treatment levels of 0 ppm IAA and 10 ppm Pb for the seventh (9.10 ± 0.47) and ninth (10.37 ± 1.81) day respectively and 0 ppm and 15 ppm Pb on the eighth (9.37 ± 0.84) day. Significant means were also obtained with the treatment level of 0 and 20 ppm IAA. This present study suggest the germination of *C. lanatus* under Pb polluted environment may be rescued with optimum IAA.
Keywords: Watermelon; Germination; Lead pollution; Phytohormone

Introduction

Watermelon, *Citrullus lanatus* (Thunberg) Matsumura and Nakai] belongs to the family Curcubitaceae and order Curcubitales. It originated in the tropics, where wild and cultivated varieties still exist with morphological differences. The plant is an annual, creeping plant with economic importance and bio energy potentials, preferred all over the world for its sugary, fleshy edible fruit, which is a thirst quencher especially during hot seasons (Bharath *et al.,* 2005; Abd-Alla *et al.,* 2007; Ogwu *et al.,* 2014; Alharbi, 2015). Fruits, leaves and seeds of *C. lanatus* have been reported to possess huge nutritional benefits, antimicrobial properties, ethnobotanical relevance, antioxidant, anti-inflammatory and analgesic potentials as well as anti-diabetic and laxative activity (Erhirhie and Ekene, 2013). *C. lanatus* is often cultivated in home gardens and outlying farms in traditional mixed cropping systems that include maize, sorghum and yam.

Hormones are vital to plant growth and if they lack them, plants would be a mass of undifferentiated cells (Davies, 1995). Phytohormones are not nutrients but chemicals that in small amounts promote and influence the growth and differentiation of cells and tissues. They are characterized by their low rates of application; high concentrations may result in opposite effect. Indole-3-acetic acid, also known as IAA is a member of the group of phytohormones called Auxin. IAA is the principal natural auxin produced by plants (Warren-Wilson *et al.,* 1999). Its molecular formula is $C_{17}H_9NO_2$, molar mass of 175.18 g/mol, and melting point, 168 - 170 ^{0}C (Jain, 2007). Auxins are toxic to plants in large concentration; they are more toxic to dicots and less so to monocots. A group of auxins known as phenoxyacetic acids including 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) form effective herbicide. IAA is the most common auxin found in plant (Taylor *et al.,* 2007). Synthetic auxin is also important in regulating plant growth and development (Bendre and Pande, 2007).

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Lead (Pb) is one of the most common heavy metal pollutants in recent times especially in urban and suburban centers. It is highly toxic and although the target is the nervous system, it can affect almost every organ and system in the body. Lead as a soil contaminant is a widespread issue since lead is present in natural deposits and may also enter soil through leaded gasoline leaks from underground storage tanks or through a waste-stream of lead paint or lead grindings from certain industrial operations (Bergeson, 2008). These may end up in the food chain as plants absorb them from the soil with their roots. Therefore, it is necessary to clean up from the environment. The seeds of many cucurbits are non-endospermic and germination is epigeal (Singh *et al.,* 2001). Seed germination is controlled by a number of mechanisms and is necessary for the growth and development of the embryo, resulting in the eventual production of a new plant (Miransari and Smith, 2014). This process can be exploited to improve the environment by absorbing unwanted contaminants from the environment.

The present study aims to investigate the effects of Indole-3-acetic acid on the germination of *C. lanatus* in lead polluted petri dishes. The study will document the potentials of the phytohormone to promote *C. lanatus* seed germination in a Pb polluted environment, which may be applied in bioremediation.

Materials and Methods

Collection of fruits and seeds of *Citrullus lanatus*

Fresh fruits of *C. lanatus* (Figure 1) cultivated and supplied by Bukuru-Mangoo Farms, Jos, Nigeria were purchased at the Vegetable market, Benin-City, Nigeria. The fruits were washed with distilled, deionized water, weighed and identified by Plant Taxonomist in the Department of Plant Biology and Biotechnology, University of Benin, Nigeria as *C. lanatus*. Thereafter, the seeds were extracted, washed and sun dried for three days before use.

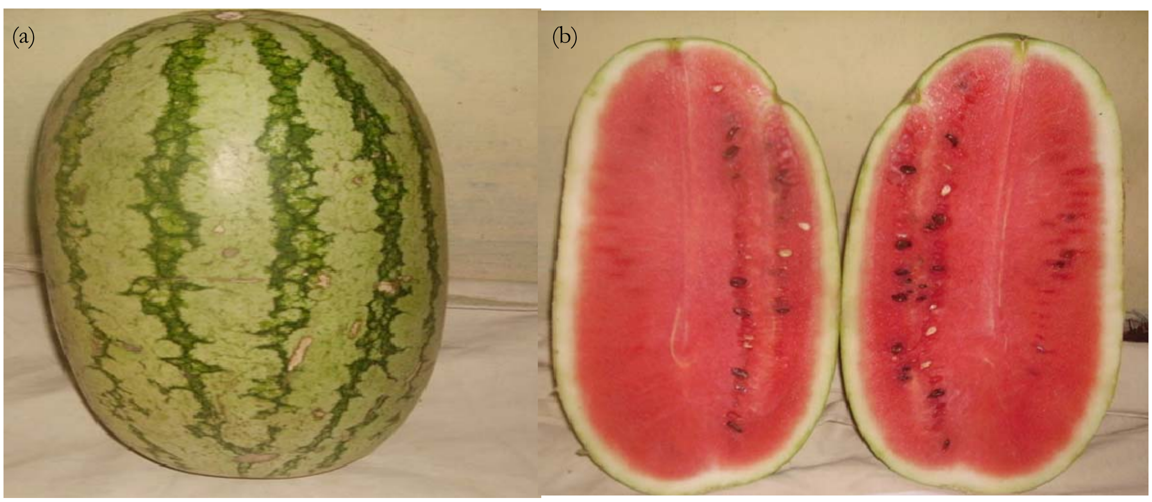

Figure 1. (a) Whole fruit of *C. lanatus* used for the study, (b) Longitudinal section of fruits of *C. lanatus,* showing mesocarp and seeds.

Preparation of seeds and laboratory

The study was conducted in the Laboratory of Plant Biology and Biotechnology Department, University of Benin. Nigeria. The experimental design adopted was complete randomized block design. The laboratory was thoroughly cleaned and sterilized using methylated spirit and cotton wool; before, during and after the studies. Whatman filter papers were properly laid out in the Petri dishes. The samples were cleaned manually to remove all foreign matter, dust, dirts, broken and immature seeds.

Plant growth regulator and lead solution

The auxin (Indole-3-acetic acid, IAA) used in this experiment was obtained from the Plant Physiology Division of the Nigerian Institute for Oil Palm Research near Benin City, Edo State. The synthetic IAA was kept in a cool dry place until required for use. The lead tetraoxosulphate (VI) [$PbSO_4$] used was obtained from the Department of Chemistry, Faculty of Physical Sciences, University of Benin.

The IAA solution was prepared by dissolving 1 g of IAA crystals, using a mild solution of sodium hydroxide (0.1 g NaOH) in about 100 ml distilled water in a 1 liter standard flask. The solution was then made up to the 1000 ml mark with distilled water. This gave a stock solution of 1 g/l of IAA. This stock solution was then serially diluted to obtain five different concentrations of IAA; 1 ppm IAA, 5 ppm IAA, 10 ppm IAA, 20 ppm IAA and 0 ppm IAA control (no IAA). It should be noted that the stock solution of 1 g/l is equivalent to 1000 mg/l. The lead solution was prepared by serially diluting a 0.5 g/l stock solution of $PbSO_4$ using distilled water. The following concentrations were obtained: 5 ppm Pb, 10 ppm Pb, 15 ppm Pb, 20 ppm Pb and 0 ppm Pb control (no Pb). The application of IAA and lead in this was done by soaking the seeds in the different concentrations. This was done using syringes every other day for ten days.

Germination test

Floatation test was used to test seed viability prior by to actual germination test. Only viable seeds were adopted and used. A Petri dish containing well laid filter paper soaked in distilled water was used. Ten seeds per variety of *C. lanatus* were placed in the Petri dish and left for 10 days. Ninety percent germination was observed 4 - 7 days after sowing.

Data collection and statistical analysis

Data was collected by counting to estimate percentage of germinated seed and a ruler graduated in centimeter to measure the seedling shoot and root length from each seed in the various treatment levels. The effects of treatments on the measured variables were detected using PAST (Paleontological Statistics, version 1.34 for windows) to determine mean ± standard error and ANOVA to compare the means of the different treatments, where significant and non-significant F-values were obtained.

Results and Discussion

Effects of IAA on germination in lead polluted petri dish of C*. lanatus seeds*

Table 1 shows the effect of IAA on the germination of *C. lanatus* seeds in lead polluted Petri dish after 7 days. The treatment of seeds with 0 ppm IAA (control) and 0 ppm Pb, 5 ppm Pb, 10 ppm Pb, 15 ppm Pb and 20 ppm Pb has a germination percentage values 87.00 ± 7.00, 87.00 ± 7.00, 100.00 ± 0.00, 100.00 ± 0.00 and 100.00 ± 0.00 respectively. The treatment of seeds with 10 ppm IAA in combination with 0 ppm Pb, 5 ppm Pb, 10 ppm Pb, 15 ppm Pb and 20 ppm Pb had the following percentages 100.00 ± 0.00, 100.00 ± 0.00, 80.00 ± 20.00, 43.00 ± 17.00 and 63.00 ± 27.00 in that order.

Table 1. Effect of IAA in Lead polluted petri dish on the germination percentage (%) of *C. lanatus* seeds after 7 days.

Treatment	0 ppm IAA	1 ppm IAA	5 ppm IAA	10 ppm IAA	20 ppm IAA
		(%)			
0 ppm Pb	87.00 ± 7.00	83.00 ± 17.00	80.00 ± 6.00	100.00 ± 0.00	83.00 ± 9.00
5 ppm Pb	87.00 ± 7.00	97.00 ± 3.00	90.00 ± 10.00	100.00 ± 0.00	50.00 ± 21.00
10 ppm Pb	100.00 ± 0.00	80.00 ± 6.00	63.00 ± 3.00	80.00 ± 20.00	57.00 ± 19.00
15 ppm Pb	100.00 ± 0.00	73.00 ± 9.00	97.00 ± 3.00	43.00 ± 17.00	70.00 ± 12.00
20 ppm Pb	100.00 ± 0.00	93.00 ± 7.00	90.00 ± 6.00	63.00 ± 27.00	73.00 ± 9.00
Level of Significance	NS	NS	*	NS	NS

Values are means of 3 determinations ± Standard Error, NS = Not significant and, * = Significant F-values

During seed extraction from fruits, viviparity was observed. Under the experimental condition, above 50 % germination was recorded from almost all the treatment levels. In the study of Ogwu *et al.* (2014) under similar lead treatment levels, the plant showed different degree of response to the pollutant. The germination of seeds began on the fourth day in all the varieties and the highest germination rate was observed in 10 ppm and the lowest in 20 ppm for all the varieties of water melon assessed, which shows certain levels of agreement with the present study. The improve results in the present study may be attributed to the addition of IAA. The results is not in agreement with the reports of Pourrut *et al.* (2011) that lead strongly inhibits seed germination, root elongation, seedling development, plant growth, transpiration, chlorophyll production, and water and protein content. More so, the results of the present study suggests the seeds had no dormancy problems regardless of lead pollutant. Dormancy of cucurbit seeds results from embryo dormancy, seed coat barrier, germination inhibiting substance and phytohormones imbalance (Liu and Long, 2008). Injuring seed coats, phytohormones treatments and chemical treatments can be used to break dormancy of cucurbit seeds. Most of the dormant cucurbit seeds can germinate in special condition. The germination ability of cucurbit seeds is related both to external and internal factors including inter and within variation. The failure of some cucurbit seed to germinate may at times have no relation to seed quality but may also be due to lack of specific requirement (Nerson, 2007). The study by Ogwu and Oladeji (2014) reports lead is present in municipal waste effluent, which may in association with other toxic heavy metals cause behavioral, biochemical and haematological in organisms including *Rattus norvegicus*. Indiscriminate germination of discarded *C. lanatus* seeds and their eventual consumption pose risk to consumer. As some Cucurbit seeds can accumulate these compounds in their tissue as they grow in polluted environment posing potential treats to other members of the food chain (Ogwu *et al.,* 2014).

Effects of IAA on seedling shoot length (cm) of *C. lanatus* seeds in lead polluted petri dish

Table 2 shows the effect of IAA on seedling shoot length (cm) in lead polluted Petri dish after 7 days. The treatment of seeds with 0 ppm IAA and 10 ppm Pb had 11.30 ± 0.46, 1 ppm IAA and 15 ppm Pb had 10.33 ± 1.24, 5 ppm IAA and 20 ppm Pb had 7.37 ± 1.12, 10 ppm IAA and 5 ppm Pb had 5.90 ± 1.04 and 20 ppm IAA and 15 ppm Pb had 6.10 ± 0.35. Table 3 shows the effect of IAA on seedling shoot length (cm) of *C. lanatus* in lead polluted Petri dish after 8 days. The treatment of seeds with 0 ppm IAA and 10 ppm Pb had 13.30 ± 0.56, 1 ppm IAA and 15 ppm Pb had 12.13 ± 2.06, 5 ppm IAA and 20 ppm Pb had 8.97 ± 1.12, 10 ppm IAA and 5 ppm Pb had 7.43 ± 1.10 and 20 ppm IAA 15 ppm Pb had 8.40 ± 0.87.

Table 4 shows the effect of IAA on seedling shoot length (cm) in lead polluted Petri dish after 9 days. The treatment of seeds with 0 ppm IAA and 10 ppm Pb had 15.10 ± 1.30, 1 ppm IAA and 20 ppm Pb had 15.27 ± 0.96, 5 ppm IAA and 20 ppm IAA had 10.93 ± 0.80, 10 ppm IAA and 5 ppm Pb had 10.27 ± 1.07 and 20 ppm IAA and 15 ppm Pb had 9.27 ± 0.82.

Table 2. Effect of IAA on seedling shoot length (cm) of *C. lanatus* in lead polluted Petri dish after 7 days

Treatment	0 ppm IAA	1 ppm IAA	5 ppm IAA (cm)	10 ppm IAA	20 ppm IAA
0 ppm Pb	6.33 ± 0.78	5.40 ± 1.78	4.33 ± 0.34	3.90 ± 1.56	2.10 ± 0.87
5 ppm Pb	8.00 ± 0.12	8.27 ± 0.21	5.23 ± 1.76	5.90 ± 1.04	0.00 ± 0.00
10 ppm Pb	11.3 ± 0.46	9.63 ± 0.32	3.97 ± 1.24	5.67 ± 3.23	1.40 ± 1.40
15 ppm Pb	9.77 ± 1.56	10.33 ± 1.24	6.83 ± 1.54	2.13 ± 0.59	6.10 ± 0.35
20 ppm Pb	8.00 ± 0.66	9.70 ± 0.35	7.37 ± 1.12	3.43 ± 1.72	1.57 ± 0.83
Level of significance	*	NS	NS	NS	*

Values are means of 3 determinations ± Standard Error, NS = Not significant and, * = Significant F-values

Table 3. Effect of IAA on seedling shoot length (cm) of *C. lanatus* in lead polluted Petri dish after 8 days

Treatment	0 ppm IAA	1 ppm IAA	5 ppm IAA (cm)	10 ppm IAA	20 ppm IAA
0 ppm Pb	8.07 ± 0.58	6.53 ± 0.21	4.20 ± 0.53	4.87 ± 0.53	2.17 ± 1.60
5 ppm Pb	9.70 ± 0.12	9.97 ± 2.27	5.97 ± 1.78	7.43 ± 1.10	0.00 ± 0.00
10 ppm Pb	13.3 ± 0.56	10.9 ± 0.32	5.23 ± 1.73	6.53 ± 3.45	2.07 ± 2.07
15 ppm Pb	11.00 ± 1.68	12.13 ± 2.06	7.97 ± 1.66	2.93 ± 0.75	8.40 ± 0.87
20 ppm Pb	9.60 ± 0.35	10.90 ± 0.38	8.97 ± 1.12	4.30 ± 2.17	1.97 ± 1.10
Level of significance	*	NS	NS	NS	*

Values are means of 3 determinations ± Standard Error, NS = Not significant and * = Significant F-values

Table 4. Effect of IAA in Lead polluted petri dish on seedling shoot length (cm) of *C. lanatus* after 9 days

Treatment	0 ppm IAA	1 ppm IAA (cm)	5 ppm IAA	10 ppm IAA	20 ppm IAA
0 ppm Pb	9.83 ± 1.52	8.30 ± 2.38	5.57 ± 0.71	6.80 ± 2.40	3.43 ± 1.36
5 ppm Pb	13.97 ± 0.92	12.20 ± 2.60	8.50 ± 2.40	10.27 ± 1.07	0.00 ± 0.00
10 ppm Pb	15.10 ± 1.30	13.77 ± 0.50	6.53 ± 1.60	8.20 ± 3.95	2.30 ± 2.30
15 ppm Pb	13.50 ± 2.12	14.53 ± 1.51	9.30 ± 1.63	5.53 ± 1.31	9.27 ± 0.82
20 ppm Pb	12.80 ± 1.21	15.27 ± 0.96	10.93 ± 0.80	6.47 ± 3.35	2.43 ± 1.31
Level of significance	NS	NS	NS	NS	*

Values are means of 3 determinations ± Standard Error, NS = Not significant and * = Significant F-values

After the seventh, eighth and ninth day, the combined treatment level of 1 ppm IAA and 15 ppm Pb had the highest seedling shoot length which is not in line with the results obtained by Ogwu *et al.* (2014). The emergence and development from the seed embryo of those essential structures which, for the kind of seed tested indicate its ability to develop into a normal plant under favourable conditions (Sweedman and Merritt, 2006). The present results supports the conclusion of Ogwu *et al.* (2014) that at low concentration of lead, *C. lanatus* seeds can initiate growth but as the concentration increases, the germination and growth can be affected. With the addition to IAA as obtained in this study, the growth and development maybe sustained. Excessive lead accumulation in plant tissue impairs various morphological, physiological, and biochemical functions in plants, either directly or indirectly, and induces a range of deleterious effects including changing cell membrane permeability, inhibition of ATP production, lipid peroxidation, and DNA damage by over production of ROS (Pourrut *et al.*, 2011). Lead has been reported to strongly affect the seed morphology and physiology (Sethy and Ghosh, 2013).

Effects of IAA on seedling root length (cm) of *C. lanatus* seeds in lead polluted petri dish

Table 5 shows the effect of IAA on seedling root length (cm) in lead polluted Petri dish after 7 days. The treatment of seeds with 0 ppm IAA and 10 ppm Pb had 9.10 ± 0.47, 1 ppm IAA and 20 ppm Pb had 6.30 ± 1.67, 5 ppm IAA and 10 ppm Pb had 1.80 ± 0.55, 10 ppm IAA and 5 ppm Pb had 1.50 ± 0.51 and 20 ppm IAA and 0 ppm Pb had 0.73 ± 0.29. Table 6 shows the effect of IAA on seedling root length (cm) in lead polluted Petri dish after 8 days. The treatment of seeds with 0 ppm IAA and 15 ppm Pb had 9.37 ± 0.84, 1 ppm IAA and 20 ppm Pb had 7.20 ± 1.50, 5 ppm IAA and 10 ppm Pb had 2.60 ± 0.83, 10 ppm IAA and 5 ppm Pb had 1.93 ± 0.66 and 20 ppm IAA and 15 ppm Pb had 0.93 ± 0.15. Table 7 shows the effect of IAA on seedling root length (cm) in lead polluted Petri dish after 9 days. The treatment of seeds with 0 ppm IAA and 10 ppm Pb had 10.37 ± 1.81, 1 ppm IAA and 20 ppm Pb had 10.57 ± 1.95, 5 ppm IAA and 10 ppm Pb had 3.73 ± 1.07, 10 ppm IAA and 5 ppm Pb had 2.67 ± 0.74 and 20 ppm IAA and 15 ppm Pb had 1.67 ± 0.26.

Table 5. Effect of IAA in Lead polluted petri dish on seedling root length (cm) of *C. lanatus* after 7 days

Treatments	0 ppm IAA	1 ppm IAA (cm)	5 ppm IAA	10 ppm IAA	20 ppm IAA
0 ppm Pb	1.60 ± 0.46	1.20 ± 0.15	0.67 ± 0.07	0.60 ± 0.12	0.73 ± 0.29
5 ppm Pb	2.77 ± 0.56	3.70 ± 1.86	1.40 ± 0.52	1.50 ± 0.51	0.00 ± 0.00
10 ppm Pb	9.10 ± 0.47	5.83 ± 1.45	1.80 ± 0.55	1.47 ± 1.07	0.33 ± 0.33
15 ppm Pb	7.87 ± 0.81	5.50 ± 1.80	1.47 ± 0.27	0.63 ± 0.22	0.57 ± 0.17
20 ppm Pb	5.13 ± 0.77	6.30 ± 1.67	1.33 ± 0.18	0.77 ± 0.38	0.43 ± 0.30
Level of significance	*	NS	NS	NS	NS

Values are means of 3 determinations ± Standard Error, NS = Not significant and * = Significant F-values

Table 6. Effect of IAA in Lead polluted petri dish on seedling root length (cm) of *C. lanatus* after 8 days

Treatments	0 ppm IAA	1 ppm IAA (cm)	5 ppm IAA	10 ppm IAA	20 ppm IAA
0 ppm Pb	2.03 ± 0.50	1.80 ± 0.46	1.00 ± 0.12	0.87 ± 0.27	0.77 ± 0.58
5 ppm Pb	3.97 ± 0.88	4.70 ± 2.03	2.13 ± 0.71	1.93 ± 0.66	0.00 ± 0.00
10 ppm Pb	8.97 ± 1.83	6.60 ± 1.42	2.60 ± 0.83	1.70 ± 1.02	0.33 ± 0.33
15 ppm Pb	9.37 ± 0.84	6.00 ± 1.85	1.93 ± 0.24	0.90 ± 0.15	0.93 ± 0.15
20 ppm Pb	6.73 ± 1.09	7.20 ± 1.50	2.10 ± 0.36	0.97 ± 0.48	0.67 ± 0.44
Level of significance	*	NS	NS	NS	NS

Values are means of 3 determinations ± Standard Error, NS = Not significant and * = Significant F-values

Table 7. Effect of IAA in Lead polluted petri dish on seedling root length (cm) of *C. lanatus* after 9 days

Treatment	0 ppm IAA	1 ppm IAA (cm)	5 ppm IAA	10 ppm IAA	20 ppm IAA
0 ppm Pb	2.83 ± 0.23	2.97 ± 0.54	2.03 ± 0.34	1.40 ± 0.46	1.40 ± 0.59
5 ppm Pb	4.37 ± 0.70	5.70 ± 2.18	3.57 ± 1.04	2.67 ± 0.74	0.00 ± 0.00
10 ppm Pb	10.37 ± 1.81	7.97 ± 1.68	3.73 ± 1.07	2.67 ± 1.62	0.47 ± 0.4.7
15 ppm Pb	9.73 ± 0.23	8.77 ± 1.59	3.57 ± 0.12	1.73 ± 0.50	1.67 ± 0.26
20 ppm Pb	8.07 ± 0.35	10.57 ± 1.95	3.43 ± 0.63	1.57 ± 0.83	0.70 ± 0.36
Level of significance	*	NS	NS	NS	NS

Values are means of 3 determinations ± Standard Error, NS = Not significant and * = Significant F-values

Despite its lack of essential function in plants, lead is absorbed by them mainly through the roots from growth media and thereby may enter the food chain. After uptake, lead primarily accumulates in root cells, because of the blockage by Casparian strips within the endodermis as well as by the negative charges that exist on roots' cell walls (Pourrut *et al*., 2011). After the seventh and ninth day, the combined treatment level of 0 ppm IAA and 10 ppm Pb has the highest seedling root length while on the eight day the combined treatment level of 0 ppm IAA and 15 ppm Pb had the highest seedling root length. This is in agreement with the results of Ogwu *et al.* (2014) but not in accordance with Munzuroglu and Geckil (2002), that plants have reduced seed germination rate, root, and hypocotyls or coleoptile length with increasing concentrations of metals including Pb. Lead has a negative effect on germination (Atici *et al*., 2003). This was not observed in the result and this may be due to the IAA treatments which reduced the effect of the Pb. Higher concentrations especially at 20 ppm IAA in combination with 0 ppm, 5 ppm, 10 ppm, 15 ppm and 20 ppm lead pollution was shown to inhibit the rate of germination of seedlings as it had the lowest germinability. Seed germination and growth in low concentration of IAA were either as good as, or slightly better than those of the control (Tsung and Tang, 1998). In a study on maize by Wang *et al.* (2007); it was shown that exogenous application of IAA significantly increases Pb accumulation in roots, but significantly decreased Pb accumulation in shoot.

Conclusions

Rapid industrialization of our planet by the human race will ensure lead pollution is a pertinent concern. The need to control the lead levels in a given environment makes it paramount to exploit available options. Previous studies have highlighted that *C. lanatus* is relevant in this process by absorbing and germinating in lead polluted environments. The present study suggest with IAA treatment in lead polluted environment *C. lanatus* showed hastened germination and initiated growth and development. More so, the reduced germinability as lead concentration increases have been shown through this study that IAA can play roles to overcome such challenge. Thus, higher concentrations of Pb treatment did not inhibit neither seedling shoot nor root growth. The results also implicates the seed quality of *C. lanatus* as high. In conclusion, this work has established that the germination of *C. lanatsus* in lead polluted environment can be rescued with IAA treatments.

References

Abd-Alla, M.A., El-Mohamedy, R.S. and El-Mougy, N.S. 2007. Control of sour rot disease of lime fruits using saprophytic isolates of yeast. Egyptian Journal of Phytopathology, 38 (2) 39 - 51.

Alharbi, A.A. 2015. Impact of biocontrol agents, T*richoderma* spp. and *Pseudomonads* spp. on root rot fungi *Fusarium solani* and *Rhizoctonia solani* infected watermelon plants cultivated in Jazan, KSA. Life Science Journal, 12(12): 43-52.

Atici, O. Gar, G.A. and Battal, P. 2005. Changes in phytohormone contents in chickpea seeds germinating under lead and zinc stress. Biologia Plantarum, 49:215-222.

Bendre, A.M. and Pande, P.C. 2007. Growth and growth hormone. Introductory botany. Rastogi Publication, India. 998 pp.

Bergeson, L.L. 2008. The proposed lead NAAQS: Consideration of cost in the air act's future. Environmental Quality Management, 18:79-95.

Bharath, B.G., Lokesh, S., Rai, V.R. Prakash, H.S. Yashovarma, B. and Shetty, H.S. 2005. Role of folia spray in the infection biology and management of fungal diseases of watermelon [*Citrullus lanatus* (Thunb.) Matsum and Nakai]. World Journal of Agricultural Sciences, 1(2): 105-108.

Davies, P.J. 1995. The plant hormones, their nature, occurrence and Function. In: Davies, P.J. (ed.). Plant Hormones, Physiology, Biochemistry and Molecular Biology. Kluwer Academy, Netherland. Pp. 1-12.

Erhirhie, E. O. and Ekene, N. E. 2013. Medicinal values on *Citrullus lanatus* (Watermelon): Pharmacological Review. International Journal of Research in Pharmaceutical and Biomedical Sciences, 4(4): 1305-1312.

Jain, V. K 2007. Fundamentals of plant physiology. Schand and Company Ltd., New Delhi, India. 594 pp.

Liu, Z.G. and Long, M.H. 2008. Progress of dormancy and germination of cucurbit seeds. Journal of Changjiang Vegetable, 5:31-33.

Miransari, M and Smith, D. C. 2014. Plant hormones and seed germination. Environmental and Experimental Botany, 99: 110–121.

Munzuruoglu, O. and Geckil, H. 2002. Effects of metals on seed germination, root elongation and coleoptile and hypocotyls growth in *Triticum aestivum* and *Cucumis sativus*. Journal of Environmental Contamination and Toxicology, 43:203-213.

Nerson, H. 2007. Seed production and germination of cucurbit crops. Seed Science and Biotechnology, 1:1-10.

Ogwu, M.C. and Oladeji, T.S. 2014. Effects of municipal waste effluent on albino rat (*Rattus norvegicus* Amori). Italian Journal of Occupational and Environmental Hygiene, 5(1): 4-10.

Ogwu, M.C., Chime, A.O., Osawaru, M.E. and Emoekpere, R. 2014. Germination of water melon *Citrullus lanatus* (Thunberg) Matsumura and Nakai, Curcubitaceae in lead polluted petri dish. Italian Journal of Occupational and Environmental Hygiene, 5(3-4): 126 -130.

Pourrut, B. Shahid, M., Dumat, C., Winterton, P. and Pinelli, E. 2011. Lead uptake, toxicity, and detoxification in plants. Review of Environmental Contamination and Toxicology, 213: 113 – 136.

Sethy, K. S. and Ghosh, S. 2013. Effects of heavy metals on germination of seeds. Review article. Journal of Natural Science, Biology and Medicine, 4(2): 272 – 275.

Singh, S., Singh, P., Sanders, D.C and Wehner, T.C. 2001. Germination of watermelon seeds at low temperature. Cucurbit Genetics Cooperative Report, 24:59-64.

Sweedman, L. and Merritt, D. 2006. Australian seeds: a guide to their collection, identification and biology. CSIRO Publishing, Collinwood, Australia. 258 pp.

Taylor, D.J., Green, N.P. and Stout, G.W. 2007. Coordination and control in plants. In: Soper, R. (ed.) Biological Science. Cambridge University Press. 539 pp.

Tsung, L.L. and Tang, Y.W. 2000. Growth stimulation by manganese sulphate, indole-3-Acetic Acid and colchicine in the Seed Germination and early Growth of several Cultivated Plants. Journal of the Botanical Society of America. 45:128-136.

Wang, H., Shan, X., Wen, B., Owens, G., Fang, J. and Zhang, S. 2007. Effects of indole-3- acetic acid on lead accumulation in maize (*Zea mays* L.) Seedlings and the relevant Antioxidant Response. Environmental and Experimental Botany, 61:246-253.

Warren-Wilson, P.M, Palm, L.M.S and Warren-Wilson, J. 1999. Auxin concentration in nodes and internodes of *Impatiens sultani*. Annals of Botany, 82:285-307.