JASEM ISSN 1119-8362

Full-text Available Online at
http:// www.bioline.org.br/ja

J. Appl. Sci. Environ. Mgt. 2004
Vol. 8 (2) 51 - 53

Effect of Pb, Cu and Fe compounds on the germination and early seedling growth of tomato varieties

[1*]JAJA, E T; [2]ODOEMENA, C S I

[1]Department of Biological Science, Rivers State University of Science and Technology, Port Harcourt .E-mail: emyljay@yahoo.com
[2]Department of Botany and Microbiology, University of Uyo, Uyo

ABSTRACT: The germination and early seedling growth of two tomato seed varieties (NHLe 158-3 and ROMA VF) were investigated using five levels (0% 0.001% 0.01% 0.1% 1%) of lead acetate, cupric carbonate and ferric chloride respectively. The experiment was conducted under 12±2h photoperiodic laboratory condition in a laboratory germinator. The results showed that the aggregate germination percentage (AGP) as well as the coefficient of germination velocity (CGV) decreased with increase in the levels of metallic compounds on the two tomato varieties. The decreases in AGP and CGV were significant ($p<0.05$) when compared with that of the control. The decrease in the growth parameters tested was higher in Roma VF than in NHLe 158-3 variety. Lead acetate and copper chloride salts indicated higher inhibitory tendencies to the germination and growth of the tomato varieties than the Ferric chloride. The study shows that NHLe 158-3 variety is more tolerant to metallic compounds pollutants than the Roma VF. @JASEM

Pollution of agricultural farmlands by heavy metals is on the increase. Some environmentalists earlier identified various sources of such pollutions in the natural terrestrial ecosystem to include air-borne metals from automobile exhaust fumes, paint and battery factories and other industrial activities (Chisolm, 1971; Singh *et al.,* 1983; Odoemena and Akpabio, 1997). The consequences of accumulation of such metals include reduction in the metabolic activity of many soil microorganisms with a subsequent decrease in the soil CO_2 evolution (Caxufield, 1961) as well as leaf necrosis and chlorosis in higher plants (Bernstein, 1961; Truby and Raba, 1990).

The importance of tomato fruits as good sources of ascorbic acid (Vit. c), β-Carotene and mineral elements has been acknowledged (Tindal, 1992). Just like many other West African Countries, Nigeria has high potential for increased production of tomato if all modern horticultural techniques are employed in a minimized or free heavy metals polluted environment.

This study therefore was carried out in order to examine the individual effect of $CuC0_3$, $(CH_3COO)_2Pb$ and Fe_2Cl_3 on two tomato varieties with the aim that the results will assist in recommending a more tolerant variety suitable for production in metallic compounds contaminated environment.

MATERIALS AND METHODS

The NHLe 158-3 and Roma VF tomato (*Lycopersicon esculentum,* Mill) seed varieties were obtained from the National Horticultural Research institute, Ibadan, Nigeria. Three hundred viable seeds of the tomato varieties each were surface sterilized with 0.1% mercuric chloride for 30 seconds and rinsed several times with distilled water. Sterilized glass petri dishes of approximately 9cm in diameter, each containing 2 Whatman No. 1 filter papers were used as sowing container and media. Twenty seeds of each tomato variety were sown in each of the petri dishes for different metallic compound treatment levels. Pollution was established by adding 6ml of the respective metallic compound solutions (Lead acetate, Cupric Carbonate and Ferric chloride) at the various concentrations into the petri dishes before sowing. The following concentrations of each of the salts were 0%, 0.001%, 0.01%, 0.1% and 1% prepared using serial dilution method. Distilled water was used as the control treatment. The petri dishes were kept under 12±2h photoperiodic condition in a laboratory germinator at 26 ± 10^0C for germination study and the seedling growth performances observed for 21 days post germination. Each treatment was replicated three times and the solutions were replenished every other day.

The criterion used for seed germination was taken as emergence of 2mm radicle at the time of observation (Odoemena, 1988). Germination counts were recorded at 2 days intervals for 12 days after sowing and the seedlings were allowed to grow. The germination percentage of the seeds were finally determined for each of the treatments. The data were expressed as aggregate germination percentage (AGP) and coefficient of germination velocity (CGV) according to the formular of Hartmann and Kester, (1964).

$$CGV = \frac{\text{Total number of Seedling}}{A_1T_1 + A_2T_2 + A_xT_x}$$

*Corresponding author

Where A = the number of seedlings emerging on a particular number of days (T), and subscripts $_{1, 2}$, … x are respective number of germinated seeds per respective number of days after sowing of the seeds. After 21 days, the experiment was terminated, and the growth parameters estimated after uprooting and cleaning the seedlings. The root and shoot lengths were measured in centimeter using a metre rule and the root/shoot ratio was calculated by dividing the root length with that of the shoot. The leaf area was determined by multiplying the length and width of the leaf by a correction factor (0.75) according to the method of Verma and Poonia (1983). The fresh weight (in grams per 20 seedlings) was measured with a weighing balance.

Thereafter, the petri-dishes containing the fresh seedlings were placed in a desicator which contained a petri dish of activated silica gel for 48 hours and sun dried to a constant weight. The moisture content was obtained by the difference between the fresh weight and dry weight. Data obtained were subjected to the analysis of variance (ANOVA) using the method of Steel and Torrie (1980).

RESULTS AND DISCUSSION

The aggregate germination percentage (AGP) and coefficient of germination velocity (CGV) of the two tomato seed varieties decreased with increased concentrations of the metallic compounds (Fig I and Table I). The mean AGP and CGV values of the seeds under the salt treatments were lower than those of the control treatment. Also the AGP and CGV values of NHLe158-3 seed were respectively higher than those of Roma VF. Ferric salt contamination was less deleterious when compared with those of lead and copper salts as evidenced by the highest AGP values obtained (Fig I). The decrease in the values of AGP and CGV of the tomato varieties caused by the increased amount of metallic compounds indicates that at a lower concentration, the contaminants posed little or no harm on the seed viability, but at a higher level, germination is retarded. This is in line with earlier reports by Bernstein (1961) and Levitt (1980).

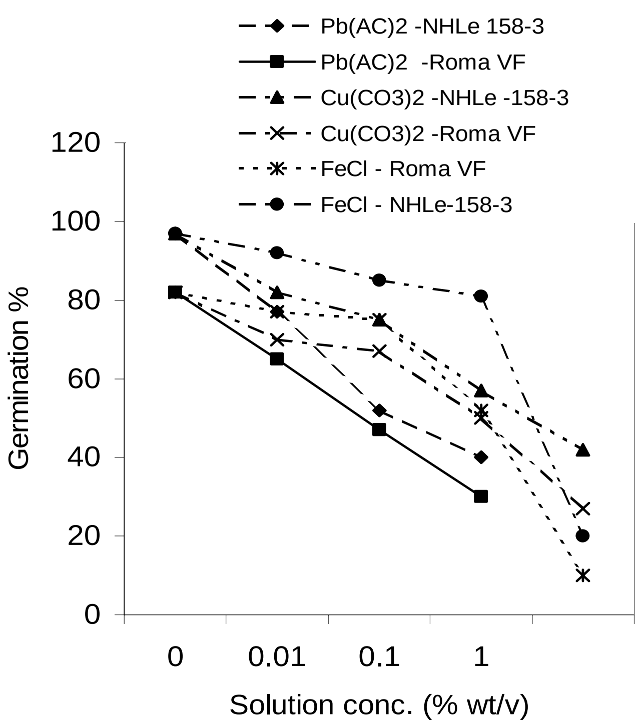

Fig 1. Effect of salt contamination on the aggregate germination of tomato seeds varieties

The root and shoot growth responses showed that increase in metallic salt content in the growing medium of the seedlings decreased (p >0.05) the root, and shoot lengths of the tomato varieties (Table 2). The results further revealed that the root and shoot lengths of NHLe 158-3 variety were higher than those of Roma VF with lead acetate treatment. The root and shoot lengths of the control treatment were higher (p<0.05) than those of the seedlings grown in the salt media. The root/shoot ratio values of NHLe 158-3 were significantly (p<0.05) lower than those of the control except that of the $FeCl_3$ treatment at 0.001% whose ratio value was of parity with that of the control,while those of the Roma VF were higher than that of the control. The highest root and shoot lengths were obtained from the seedlings of NHLe 158-3 treated with 0.001% $FeCl_3$ salt solution. The retarded growth of the tomato seedlings was more severe in Roma VF than in NHLe 158-3 with increased contamination levels. Also the impact of higher levels of the contaminants was adversely more on the seed germination ability. Suppression of seed germination and plant growth responses have been attributed to the establishment of higher toxic effect syndrome (HTES) due to high accumulation of the metallic salts within the plant body biomass (Singh and Singh, 1981; Singh *et al*., Esenowo, 1995). The reports of these authors must have explained why the results of this study decreased with increased levels of the metallic compounds.

Table 1: Effect of Pb, Cu, and Fe salts on the coefficient of germination velocity (CGV) on the two tomato varieties.

Tomato Varity	**Treatmen**	**CGV**
NHLe 158-3	Control 0	0.23
Roma VF	Control 0	0.13
NHLe 158-3	Lead acetate (%)	
0.001	0.280.01	0.21
0.1	0.181.0	0.00
Roma VF	0.001	0.16
	0.01	0.16
	0.1	0.11
	1.0	0.00
	Cupric carbonate (%)	
NHLe 158-3	0.001	0.27
	0.01	0.26
	0.1	0.23
	1.0	0.19
Roma VF	0.001	0.23
	0.01	0.21
	0.1	0.18
	1.0	0.18
	Ferric Chloride (%)	
NHLe 158-3	0.001	0.31
	0.01	0.28
	0.1	0.21
	1.0	0.21
Roma VF	0.001	0.26
	0.01	0.23
	0.1	0.19
	1.0	0.18
Mean ± SE	.2±0.02	

The leaf areas of the tomato varieties were significantly ($p < 0.05$) lower than those of the control. Also the results showed decrease in the leaf areas as the concentration of the contaminants increased (Table 3). The fresh and dry matter accumulations of the tomatos varieties also decreased with increased salt load. The fresh and dry mass values of NHLe 158-3 variety were respectively higher than those of Roma VF in lead and Ferric salts treatments. The moisture up take was appreciably higher under the control treatment. The observed reductions in the fresh and dry matter accumulations of the tomato seedlings due to increased levels of the metallic salt solutions, corroborate the reports of Esenowo (1995) and Odoemena (1999). The reduced moisture levels and the other growth parameters shown in Table 3 were more pronounced in Roma VF than in NHLe 158-3 variety.

In summary, the lower values obtained from Roma VF with respect to the growth parameters studied are indicative of the fact that NHLe 158-3 tomato variety is more tolerant to the metallic salts within the limits of contamination levels tested, than the Roma VF. Also lead acetate and copper chloride salts showed higher inhibitory growth tendencies to the crop than the ferric chloride.

Table 2: Effect of metallic compounds on the root and shoot growth of two tomato varieties

Treatment (%)	NHLe 158-3 variety			Roma VF variety		
	Root length (cm)	Shoot length (cm)	Root/shoot ratio	Root length (cm)	Shoot length (cm)	Root/shoot ratio
*Control	3.50±0.12	4.880±0.20	0.73	1.67±0.21	4.7±0.13	0.36
Lead acetate						
0.001	2.19±0.15	3.50±0.30	0.63	1.23±0.30	3.04±0.12	0.41
0.01	1.97±0.03	3.07±0.08	0.64	1.10±0.10	2.46±0.13	0.45
0.1	1.44±9.06	2.58±0.10	.56	1.03±0.02	1,75±0.02	0,59
1.0	ND	ND	ND	ND	ND	ND
$Cu(CO_3)_2$						
0.001	2.64±0.02	4.08±0.02	0.65	2.36±0.01	4.31±0.07	0.55
0.01	2.50±0.05	3.67±0.06	0.68	2.17±0.01	3.59±0.04	0.61
0.1	2.06±0.04	3.10±0.04	0.67	2.11±0.02	3.09±0.02	0.68
1.0	1.27±0.02	2.04±0.06	0.53	1.39±0.01	2.04±0.01	0.68
$FeCl_3$						
0.001	3.46±0.03	4.75±0.01	0.73	2.16±0.02	4.32±0.03	0.50
0.01	3.14±0.01	4.60±0.03	0.68	1.82±0.03	3.81±0.02	0.48
0.1	1.37±0.04	2.42±0.02	0.57	0.65±0.01	1.92±0.03	0.46
1.0	ND		ND	ND	ND	ND
Mean ± SE	2.32±0.03	3.51±0.02	0.64±0.01	1.61±0.01	3.14±0.05	0.53±0.02

ND = Not determined. * Control is distilled water

Table 3: Effect of metallic salts contamination on the leaf area, moisture content, fresh and dry weights (per 20 seedlings) of two tomato varieties.

Treatment (5)	NHLe 158-3 variety				Roma VF variety			
	Leaf area (cm^2)	Moisture content (g)	Fresh weight (g)	Dry weight (g)	Leaf area (cm^2)	Moisture content (g)	Fresh weight (g)	Dry weight (g)
*Control	0.19±1.01	0.60±0.02	0.64±0.01	0.20±0.01	0.15±0.01	0.42±0.02	0.47±0.01	0.18±0.02
Lead acetate								
0.001	0.14±0.02	0.055±0.01	0.59±0.03	0.12±0.01	0.10±0.02	0.35±0.01	0.39±0.01	0.10±0.01
0.01	0.11±0.01	0.54±0.01	0.48±0.02	0.10±0.02	0.08±0.01	0.26±0.02	0.21±0.02	0.07±0.01
0.1	0.08±0.01	0.30±0.00	0.23±0.01	0.09±0.01	0.05±0.01	0.10±0.01	0.20±0.01	0.07±0.02
1.0	ND	ND	ND	ND	ND	ND	ND	ND
$Cu(CO_3)_2$								
0.001	0.09±00.1	0.453±0.03	0.58±0.02	0.15±0.01	0.08±0.01	0.35±0.02	0.46±0.02	0.13±0.02
0.01	0.08±0.01	0.48±0.02	0.51±0.03	0.13±0.01	0.07±0.02	0.31±0.01	0.40±0.02	0.10±0.01
0.1	0.06±0.01	0.32±0.01	0.37±0.01	0.09±0.02	0.05±0.01	0.23±0.02	0.31±0.01	0.07±0.01
1.0	0.04±0.00	0.21±0.02	0.28±0.02	0.06±0.01	0.04±0.01	0.17±0.03	0.23±0.01	0.03±0.00
$FeCl_3$								
0.001	0.12±0.02	0.53±0.01	0.59±0.02	0.15±0.01	0.09±0.01	0.37±0.01	0.39±0.01	0.13±0.01
0.01	0.09±0.01	0.44±0.02	0.47±0.02	0.10±0.01	0.80±0.02	0.36±0.02	0.46±0.02	0.09±0.01
0.1	0.05±0.0	0.21±0.01	0.26±0.01	0.09±0.01	0.06±0.02	0.24±0.01	0.29±0.01	0.09±0.02
1.0	ND	ND	ND	ND	ND	ND	ND	ND
Mean ± SE	0.10±0.02	0.43±0.01	0.12±0.02	0.08±0.02	0.29±0.01	0.37±0.03	0.37±0.03	0.90±0.02

REFERENCES

Bernstein, L (1961). Osmotic adjustment of plants to saline media. *American Journal of Botany* 48:909-918.

Caxufield, A H (1961). Simple technique for determining mineralisation of carbon during incubation of soil treated with organic material. *Plant and Soil* 14:90-93.

Chisolm, J J (1971). Lead poisoning. *Science American* 224: 15-25

Esenowo, G J (1995). The effect of some heavy metals on germination and early seedling growth of two varieties of *Hibiscus esculentus*. *West African Journal of Biological and Applied Chemistry* 40:40-45.

Hartmann H T ; Kester, D E (1964). *Plant Propagation*. Principle and Practice 5th Ed. 89 115 U.S.A Prentice Hall.

Levitt, J (1980). *Responses of Plants of Environmental Stresses.* II Water, radiation, salt and other stresses. Academic Press, New York pp. 489-530.

Odoemena, C S (1988). Breaking of seed coat dormancy in a medicinal plant *Tetrapleura tetraptera*. *Journal of Agricultural Science* (Cambridge) Vol. 111 (2) 393 – 394.

Odoemena, C S (1999). Heavy metals uptake and yield performances of okra *(Abelmoschus esculentus)* grown in spent-creankcase-engine-oil polluted soil. *Journal of Applied Science & Environmental Management* 3:71-74.

Singh, K P; Singh, K (1981). Stress Physiological studies on seed germination and seedling growth of source wheat hybrids. *Indian Journal of Physiology* 24:180-186.

Steel, G D; Torrie, J H (1980). *Principle and Procedure of Statistics.* A Biometrical Approach (Second edition) McGraw-Hill Book Company Incorporated, New York, 633p.

Tindal, H D (1992). *Commercial Vegetables Growing*, Oxford Tropical Handbook pp 129 – 131.

Truby, P; Raba, A (1990). Heavy metals uptake by garden plants from Freiburg sewage farm waste water. *Agribiological – Research* 43 (2) 139-146.

Verma, S K; Poonia S R (1983). Germination and early seedling growth of pearl millet (*Pennisetum typhodes)* as affected by salinity. *Indian Journal of Plant Physiology* 26: 142-146.