Octa Journal of Environmental Research
International Peer-Reviewed Journal
Oct. Jour. Env. Res. Vol. 5(1):064-069
Available online http://www.sciencebeingjournal.com

Jan. – Mar., 2017
ISSN 2321 3655

Research Article

Octa Journal of Environmental Research
(Oct. Jour. Env. Res.) ISSN: 2321-3655
Journal Homepage: http://www.sciencebeingjournal.com

EFFECT OF LEAD ABUNDANT SOIL ON GROWTH AND YIELD OF *Oryza sativa* L

Neha Saini*, Neha Tiwari, Sandeep Dhyani
Department of Botany, Uttaranchal (PG) College of Bio-Medical Sciences and Hospital, Sewla Khurd, Dehradun
Corresponding Author E-mail: **neha.saini783@gmail.com**
Received: 18th Feb. 2017 **Revised**: 28th Mar. 2017 **Accepted**: 31st Mar. 2017

Abstract: Biologically, Lead (Pb) is toxic and harmful metal which reduces the plant growth when increased in soil, even in very small quantity. Though lead is not an essential element for plants, it get easily absorbed and accumulated in different plant parts. An experiment was conducted to investigate the toxic effects of lead on the growth and yield of Rice (*Oryza sativa* L.). During the study rice seeds were grown in soil having lead in the concentration of 50 mg/Kg soil and, growth and yield was compared with those grown in soil without lead. It was observed that lead in 50 mg/kg soil concentration was deleterious for plant growth in all the stages. Root length, shoot length, their fresh weight and dry weight decreased in the soil having lead. Similarly number of spikelet and number of seed grain per plant were also lower in plants which were grown in soil treated with lead. The results confirm the harmful effect of lead on growth and development of rice.
Keywords: Heavy metals, Lead, *Oryza sativa L.,* growth

Postal Address: Department of Botany, Uttaranchal (PG) College of Bio-Medical Sciences and Hospital, Sewla Khurd, Near Transport Nagar, Dehradun- 248002

INTRODUCTION

Soil is contaminated by heavy metals due to the results of human activities, unscientific agriculture and industrial practices. Most of the heavy metals, such as Cu, Zn, Pb and Ni are known as essential micronutrients for plants, but they proved to be toxic to organisms at high concentrations (Munzuroglu and Geckil, 2002; Kaur, 2014). Heavy metals may get easily accumulated in many biological systems and cause deleterious symptoms. Heavy metals such as lead (Pb) are of major concern because of their persistence in the environment (Melegy, 2010). Lead is ranked the number one heavy metal pollutant and number two of all hazardous substances by the Agency for Toxic Substances and Disease Registry (Gallardo *et al*., 2002; ATSDR, 2007). Lead is not biodegradable and is extremely persistent in both water and soil; it can be retained in the environment for 150–5000 years (Saxena *et al*., 1999). Lead is easily taken by the plants from the soil and is accumulated in different plant tissue. Lead toxicity decreases growth and yield in plants (Shafiq *et al*., 2008; Kumar and Jayaraman, 2014), disruption of mineral nutrition (Lamhamdi *et al*., 2013; Naresh kumar *et al*., 2014), inhibition of photosynthesis (Tian *et al*., 2014), inhibition of enzyme activity (Malar *et al*. 2014), water imbalance and alterations in membrane permeability (Sharma and Dubey 2005; Israr and Sahi, 2008). Soil contaminated with Pb cause sharp decreases in crop productivity by posing a serious problem for agriculture (Johnson and Eaton, 1980). Rice is one of the most important staple foods in Asia. About 90 percent of the total rice is cultivated in Asia (Salim *et al.*, 2003). In Asian countries, rice (*Oryza sativa)* is a food staple used for daily consumption and provides over 70% of the energy derived from daily food intake (Phuong *et al*., 1999). The objective of the study is to examine the effect of heavy metal (lead) on morphological attributes and biomass of *Oryza sativa*.

EXPERIMENTAL

For the present investigation, seeds of *Oryza sativa L.*, Linn cv. Basmati were procured from Indian Agriculture Research Institute, New Delhi. Seeds were thoroughly washed in double distilled water before sowing. To study the effect of lead on rice in terms of growth and yield, seeds were grown in soil without lead (control set) and with lead concentration (50 mg/kg soil) in polythene bags. Two kg soil was taken in each bag and irrigated whenever found necessary. Different morphological parameters such as root length, Shoot length, formation of inflorescence and biomass were investigated during experimental work. The plants samples were analyzed for vegetative growth at 40, 80 and 120 days interval after seedling emergence. 75 to 100% emergence was considered as the starting day. Five plants were randomly selected for root and shoot length and their fresh weight and dry weight was also calculated at each interval. Yield parameters such as number of spikelet per plant, number of seed per spikelet and weight of spikelet were studied at 120 day of experiment.

RESULTS AND DISCUSSION

Data obtained clearly indicates that lead had inhibitory effect on growth parameters of *O. sativa*. Table 1 indicates that the general growth of *Oryza sativa L.*, Cultivar Basmati declines in the presence of 50 mg/kg lead abundant soil as compared to control soil. Root and shoot length increased along with the days but the higher length was recorded in control set. Data for root length recorded at 120 day showed that the root length of control plants were 25 % more than the plants grown in lead abundant soil whereas shoot length recorded at the same time was 22 % more in control set than in plants grown in lead soil. Similarly lead toxicity affected the fresh weight and dry weight of *Oryza sativa*. Fresh weight and dry weight significantly decreased under lead treatment. Fresh weight of root in control was 41% higher than in plants grown under lead treatment. Similarly dry weight of root was 7.31± 0. 46gm and 5.07± 0.10gm in control and lead treated plants respectively. Likewise, fresh weight of shoot was 49% higher in control plants as compared to plants grown under lead abundant soil. Dry weight of plants grown in soil having lead was 18% less as compared to plants grown in normal soil. As it is clear from the table, there was also an inhibition in yield parameters in the present rice cultivar. Thus, in 50 mg/kg Pb abundant soil, spikelet number per plant and weight of spikelet was 39% and 25 % respectively less than the control plants. Thus, in presence of 50 mg/kg Pb abundant soil, seed number per spikelet was 33% less as compared to control.

Table 1. Growth characteristics and yield of *Oryza sativa I.* cv. basmati grown on soil without lead (control) and with lead (50 mg/kg soil)

Growth Parameters Per Plant ±SD	Days From Emeregence					
	40 Days		80 Days		120 Days	
	Control	Pb 50mg/Kg soil	Control	Pb 50mg/Kg soil	Control	Pb 50mg/Kg soil
ROOT						
Length, cm	25.10± 2.00	18.40±1.80	36.40± 4.08	26.40±2.80	37.21±1.08	27.98±0.99
Fresh weight, gm	8.30 ±0.46	4.60± 0.60	18.40±0.60	10.80±0.88	24.07±0.62	14.20±0.41
Dry weight. gm	3.20 ±0.20	2.60±0.20	5.60 ±0.26	3.80±0.60	7.31± 0. 46	5.07± 0.10
SHOOT						
Length, cm	30.80±1.46	26.40±1.80	44.10 ±1.80	38.20±1.40	81.14±1.28	64.10±1.06
Fresh weight, gm	10.25±1.30	8.00±0.46	16.00± 0.47	10.20±0.28	28.25±0.61	14.41±0.45
Dry weight. gm	3.48±0.44	2.80± 0.25	6.00 ±0.25	4.50 ± 0.24	7.41 ±0.31	6.04 ±0.11
SPIKELET						
Number / Plant	_	_	_	_	10.80±0.38	6.60 ±0.20

Weight, gm	_	_	_	_	6.00 ± 0.46	4.50 ± 0.35
SEED GRAIN						
Number/Spikelet	_	_	_	_	9.00 ±0.38	6.00 ± 0.36
Weight/ Plant, gm	_	_	_	_	8.35±0.47	2.69±0.41

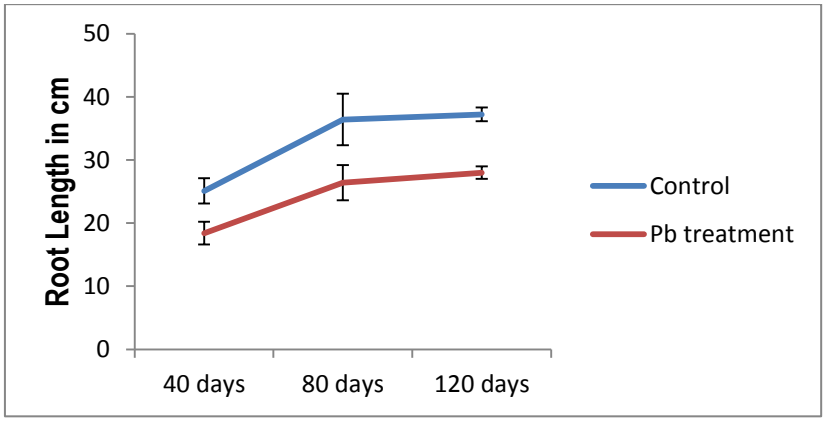

Figure 1. Root length of *Oryza sativa* in control and lead treatment at 40, 80 and 120 days interval
(Vertical bars are the means of five replications ±SD)

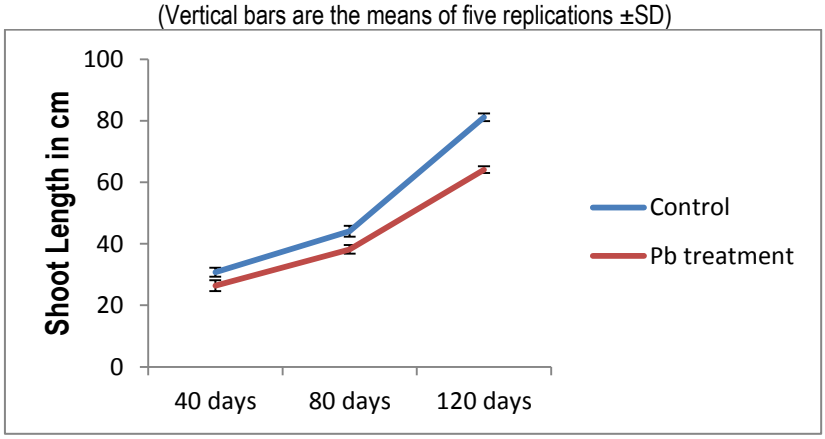

Figure 2. Shoot length of *Oryza sativa* in control and lead treatment at 40, 80 and 120 days interval
(Vertical bars are the means of five replications ±SD)

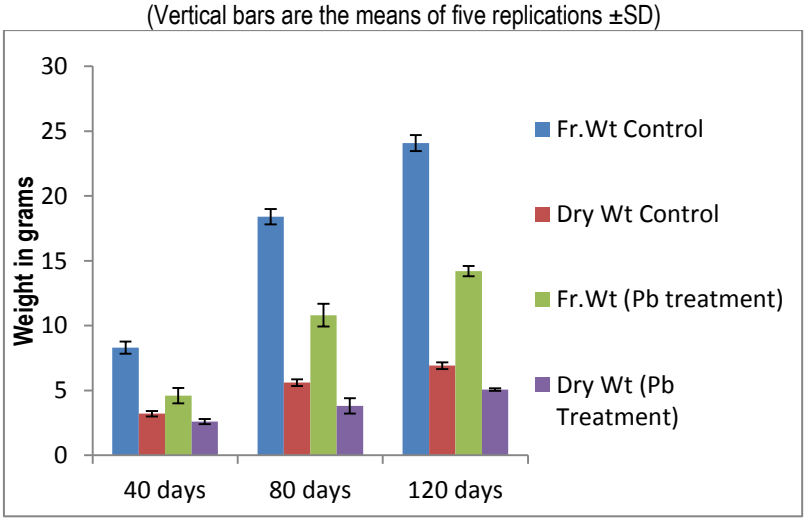

Figure 3. Fresh weight and dry weight of *Oryza sativa* roots in control and lead treatment at 40, 80 and 120 days interval
(Vertical bars are the means of five replications ±SD)

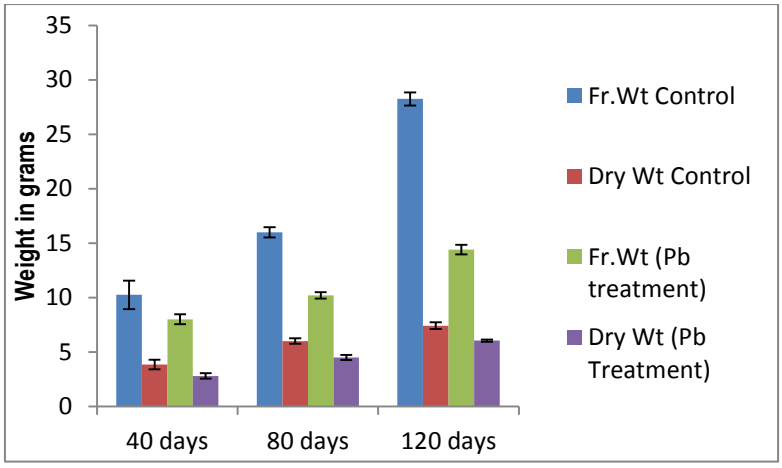

Figure 4. Fresh weight and dry weight of shoot of *Oryza sativa* in control and lead treatment at 40, 80 and 120 days interval (Vertical bars are the means of five replications ±SD)

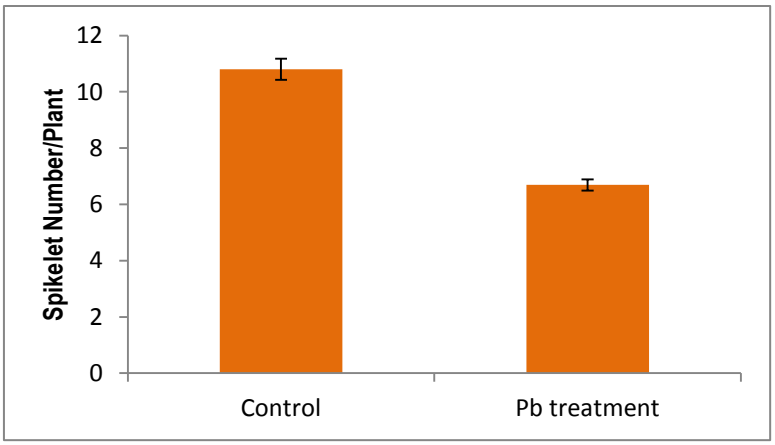

Figure 5. Number of spikelet per plant in *Oryza sativa* in control and lead Treatment
(Vertical bars are the means of five replications ±SD)

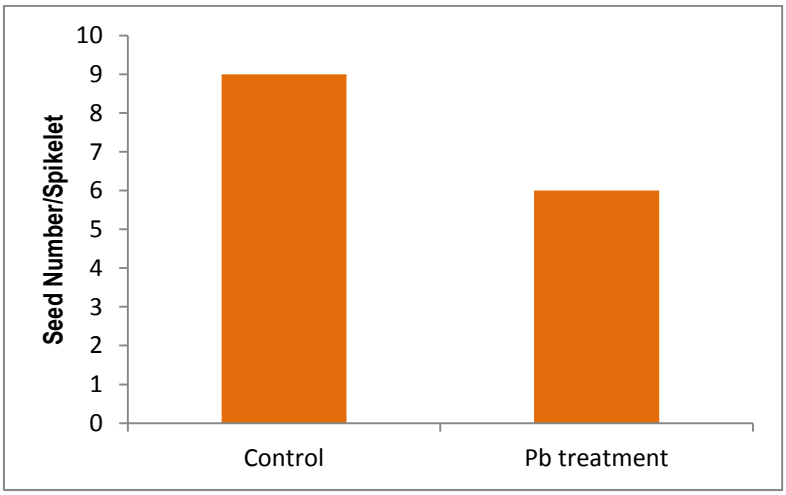

Figure 6. Number of seed per spikelet in *Oryza sativa* in control and lead treatment
(Vertical bars are the means of five replications ±SD)

Lead has gained considerable attention as a strong heavy metal pollutant due to the growing anthropogenic activity in the environment. Pb contaminated soils show a severe decline in crop productivity. It is clear from the table that the Lead concentration clearly altered the shoot and root growth. The results are in accordance with the study of Awan *et al*. (2015) in which shoot and root length of *Oryza sativa* decreased with increasing Pb concentration. The principal effect of Pb toxicity in plants is a rapid inhibition of root

growth, probably due to the inhibition of cell division in the root tip (Eun *et al*., 2000). Lead inhibits the growth performance of plant by alteration in enzyme activity and induction of oxidative stress (Kaur *et al*., 2012). Similarly presence of Pb in soil also adversely affected the fresh weight and dry weight of root as well as shoot. The decrease in fresh weight and dry weight due to lead toxicity has been reported in several studies (Kosobrukhov *et al*., 2004; Kibria *et al*., 2010; Bhatti *et al*., 2013; Awan *et al*., 2015). The observations on the effects of Lead abundant of soil on growth and yield revealed that heavy metals are inhibitory at 50mg/kg soil concentration.

CONCLUSION

Present study was conducted to check the effect of lead abundant soil on growth and yield of *Oryza sativa*. It is found that the higher concentration of lead in soil was inhibitory for the growth and yield of plant. It is observed that root and shoot length increased along with the days but the higher length was recorded in control set. Due to lead toxicity fresh weight and dry weight of *Oryza sativa* also affected. Results further indicate inhibition in the yield parameter of *Oryza sativa*. Thus it is concluded that 50 mg/kg Pb abundant soil is inhibitory for root, shoot and yield parameter of rice cultivar.

Acknowledgments: The author is thankful to Late Dr. A.K. Bhargava (Former, Head of the botany department, M.S. College Saharanpur) for his guidance guides during the experimental work and support. Author is also thankful to the entire colleagues who supported in this study.

REFERENCES

ATSDR (2007). CERCLA Priority list of hazardous substances. ATSDR Home. Retrieved March 22, 2011, from http://www.atsdr.cdc.gov/cercla/07list.html.

Awan S, Jabeen M, Qari MI, Ullah F, Mehmood Z, Jahngir M and Jamil M. (2015). Effects of Lead Toxicity on Plant Growth and Biochemical Attributes of Different Rice (*Oryza Sativa* L.) varieties. *Journal of Bio-Molecular Sciences,* 3(1): 44-55.

Bhatti KH, Anwar S, Nawaz K, Hussain K, Siddiqi EH, Sharif RU, Talat A and Khalid A. (2013). Effect of Heavy Metal Lead (PB) Stress of Different Concentration on Wheat (*Triticum aestivum* L.). Middle-East Journal of Scientific Research, 14(2):148-154.

Eun S, Youn H and Lee Y. (2000). Lead disturbs microtubule organization in the root meristem of *Zea mays*. Physiol. Plant. 44: 5-9.

Gallardo-Williams M, Whalen V, Benson R and Martin D. (2002). Accumulation and retention of lead by cattail (*Typha domingensis*), hydrilla (*Hydrilla verticillata*), and duckweed (*Lemna obscura*). J. Environ. Sci. Health, Part A, 37(8):1399-1408.

Kaur G. (2014). Pb-induced toxicity in plants: effect on growth, development, and biochemical attributes. *Journal of Global Biosciences,* 3(6):881-889.

Israr M and Sahi SV. (2008). Promising role of plant hormones in translocation of lead in *Sesbania drummondii* shoots. *Environmental Pollution,* 153:29-36.

Johnson MS and Eaton JW. (1980). Environmental contamination through residual trace matel dispersal from a derelict lead-zinc mine. *J. Environ. Qual.,* 9:175-179

Kaur, G, Singh HP, Batish DR and Kohli RK. (2012). Growth, photosynthetic activity and oxidative stress in wheat (*Triticum aestivum*) after exposure of lead Pb to soil. *J. Environ. Biol.,* 33: 265-269.

Kibria M, Maniruzzaman M, Islam M and Osman K. (2010). Effects of soil-applied lead on growth and partitioning of ion concentration in *Spinacea oleracea* L. tissues. *Soil Environ.* 29: 1-6.

Kosobrukhov A, Knyazeva I and Mudrik V. (2004). 24. *Plantago major* plants responses to increase content of lead in soil: growth and photosynthesis. Plant Growth Regulation, 42: 145-151.

Kumar M and Jayaraman P. (2014). Toxic effect of lead nitrate [$Pb(NO_3)2$] on the black gram seedlings (*Vigna mungo* (L.) Hepper). *Int. J. Adv. Res. Biol. Sci.,* 1(9):209-213.

Lamhamdi M, EL Galiou O, Bakrim A, Nóvoa-Muñoz JC, Arias-Estévez M, Aarab A and Lafont R. (2013). Effect of lead stress on mineral content and growth of wheat (*Triticum aestivum*) and spinach (*Spinacia oleracea)* seedlings. *Saudi J. Biol. Sci.,* 20(1): 29-36.

Malar S, Vikram SS, Favas PJC, Perumal V. (2014). Lead heavy metal toxicity induced

changes on growth and antioxidative enzymes level in water hyacinths [*Eichhornia crassipes* (Mart.)]. *Botanical Studies*, 55: 54-65.

Melegy A. (2010). Adsorption of lead (II) and zinc (II) from aqueous solution by bituminous coal. *Geotech. Geol. Eng.,* 28(4): 549-558.

Munzuroglu O and Geckil H. (2002): Effects of metals on seed germination, root elongation, and coleoptile and hypocotyl growth in *Triticum aestivum* and *Cucumis sativus*. *Arch. Environ. Contam. Toxicol.* 43: 203–213.

Nareshkumar A, Krishnappa BV, Kirankumar TV, Kiranmai K, Lokesh U, Sudhakarbabu O and Sudhakar C. (2014). Effect of Pb-stress on growth and mineral status of two groundnut (*Arachis hypogaea* L.) cultivars. *Journal of Plant Sciences,* 2(6): 304-310.

Phuong TD, Chuong PV, Khiem DT and Kokot S. (1999). Elemental content of Vietnamese rice. Part 1. Sampling, analysis and comparison with previous studies. *Analyst*, 124: 553–560.

Salim, M, Akram M, Akhtar M and Ashraf M. (2003). Rice, A production handbook, balanced fertilization for maximizing economic crop yields. *Pakistan Agri. Res. Council,* pp 68

Saxena PK, Krishnaraj S, Dan T, Perras MR and Vettakkorumakankav NN. (1999). Phytoremediation of heavy metal contaminated and polluted soils, In Prasad MNV and Hagemeyer J (eds.), Heavy Metal Stress in Plants: From Molecules to Ecosystem, Springer-Verlag Berlin Heidelberg, Germany, pp. 305–329.

Shafiq M, Iqbal MZ and Athar M. (2008). Effect of lead and cadmium on germination and seedling growth of *Leucaena leucocephala. J. Appl. Sci. Environ. Manage.,* 12(2): 61-66.

Sharma P and Dubey RS. (2005). Lead toxicity in plants. *Braz. J. Plant Physiol.,* 17: 35-52.

Tian T, Ali B, Qin Y, Malik Z, Gill RA, Ali S and Zhou W. (2014). Alleviation of Lead Toxicity by 5-Aminolevulinic Acid Is Related to Elevated Growth, Photosynthesis, and Suppressed Ultrastructural Damages in Oilseed Rape. *BioMed Research International*, Article ID 530642, pp11.

Source of Support: None
Conflict of interest: None, Declared.