*Article*

# Effects of lead on vegetative, propagative and physiochemical parameters of *Pisum sativum*

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**Abstract**

Pea (*Pisum sativum* L.) is a valuable proteinaceous vegetable. It has 40% contribution in economy among world pulses and 3$^{rd}$ in ranking in consumption after garlic and beans in Pakistan. Its yield is affected by many abiotic stresses e.g. salinity, water logging, heavy metals in sewage water and wastes etc. Heavy metals are great threat to humans as they are not only dangerous to humans through food chains but also reducing its cash benefits by decreasing the yield of crop plants qualitatively and quantitatively. This study aimed to investigate the effects of lead (Pb) on vegetative, propagative and physiochemical properties of pea plants. In this regard, an experiment was conducted on two cultivars i.e., meteor and classic of pea by treating them with heavy metal salt, lead nitrate ($Pb(NO_3)_2$) at flowering stage. It was hypothesized that lead will damage vegetative characters compared to control treatments and declines in agronomic yields of pea. Chemical analyses of pea plants confirmed that pea plants activated their defensive chemical mechanisms by producing certain antioxidant chemicals against lead treatment and also reduced its nutritive chemicals.

**Keywords** pea; heavy metal harms; lead accumulation; vegetables.

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## 1 Introduction

*Pisum sativum* L. from the Leguminosae family is in agricultural practice since middle ages. Pea, an annual legume is cropped in fields as it has a contribution in human food and animal forage (McKenzie and Spooner, 1999). Nuts of pea and feed stuff for livestock are good wellspring of proteins and minerals (Acikgoz et al., 1985). Two breeding of pea plants are cultivated named as; sweat or green peas and field peas. Numerous pottages created on plants contain huge number of seeds. Among the sloe nourishments, beans and their items have overall utilization. Pea contributes around 40% in the pulses and grains (Oram and Agcaoili, 1994).

Many elements are diminishing the harvest yield by affecting their development and production in Pakistan. Among them, principle ones like rash utilization of composts and shortage of seeds of suggested and verified strains lessen the product growth. Metallic micronutrients like zinc, copper and nickel etc. fasten the growing processes in plants while heavy metals aluminum, plumbous and cadmium exert disturbance to growth and improvements in plants. In low pH soils, metals of heavy category are readily soluble in water and show good flow through soil solution and are quickly available to plants (Delbari et al., 2019). Heavy metals are elements which holds densities larger than 5 $g/cm^3$ (Morsy et al., 2012). Pb, Cd, As, Cr, Co, Ni, and Hg are poisoning HMs (Hu et al., 2013). Wastes from industrial waters, smelters, incinerators and use of mud from sewage, excessive application of fertilizer and pesticides may harm the soil on huge-level. The irregularities of heavy metals pollution in soil can adversely influence the quality of soil; discourage the acreage of crops and food stuff qualities and is also responsible for deteriorating the life maintaining processes of persons, faunas and ecological system (Hu et al., 2013). In nature, pollution free soils have plumbous from 20-50 parts per million or 20-50 mg/Kg. On the other hand, the soils in factory areas have lead more than 1000 mg/Kg (Nriagu, 1978). Pb and Cd are present in good amounts in the root layer of earth crust in Pakistan (Ahmed et al., 1994). In plants, Pb usually makes the rout through interconnected cell walls of adjacent cells for translocation from soil roots to leaves (Clemens, 2006). The movement is kept on from root hairs to stele and then to foliage via xylem. Phloem is also involved a little bit in shifting of Pb between different parts of plant body (Tudoreanu and Phillips, 2004). Plants are threatened by HMs acquaintance as they are hindering nutrient absorption in plants (Kim et al., 2002), increasing amounts of lipid per-oxidation, reactive oxygen species and disorders of other physiological functions of plants (Shan et al., 2001) are observed. Plant exhibits chlorosis due to prohibition of bio manufacturing (Vassilev and Lidon, 2011), biocatalyst destruction (Vassilev and Lidon, 2011), oxidative injury (Vassilev and Lidon, 2011) and decrease in chloroplast density/cell (Baryla et al., 2001; Vassilev and Lidon, 2011) on revelation to lead. In response of heavy metals uptake, plants induces their defensive mechanisms and generates different oxidants in appreciable amounts otherwise HMs inflicts damages at cellular level and also upset the homeostatic balance. Plants use their detoxification mechanism to avoid such HMs stresses mainly based on chelation and sub-cellular compartmentalization (Yadav, 2010).

## 2 Methodology

The Ayub Agricultural Research Institute (AARI) Vegetables Section of Faisalabad, Pakistan was the Organization from where seeds of two varieties of pea i.e. meteor and classic were taken. Before sowing, seeds were grouped into two soaking categories i.e. one without soaking and other is soaking in distilled water. All types of seeds selected for experiment were kept in dark overnight. Plastic pots were filled with soil and nine seeds were sown in each pot. Treatments of lead nitrate as 0 ppm and 100 ppm were started to irrigate at flowering stage. After 120 days of applying treatment, sample of fresh plants were reaped. Samples were stored at -20 °C. Vegetative parameters and reproductive characters like length of shoot (cm), root length (cm), fresh root weight (g), shoot fresh weight (g), dry shoot and dry root weight (g), number of pods per plant, number of seeds per plant and weight of 100 seeds in grams were measured in both cultivars at all levels of $Pb(NO_3)_2$. Shoot and root dry weights (g) were determined after drying the sample plants in oven at 70 $^oC$ for 6-days. Quantitative analyses of anthocyanins were determined by spectrophotometric technique by using procedure of Kubo et al. (1999). Ascorbic acid concentration was estimated with technique of Mukherjee and Chouduri (1983). Flavonoid contents were recorded by the $AlCl_3$ colorimetric examination (Jia et al., 1999). The method adapted from Velikova et al. (2000) was utilized to calculate the $H_2O_2$. The quantity of phenolics was identified according to Rasheed et al. (2014). Analysis of variance was applied among various treatments were calculated through software COSTAT (CoHort Software 2003, Monterey, California).

## 3 Results and Discussion

Length of shoot, length of root, weight of fresh shoot, weight of fresh root, weight of dry shoot and weight of dry root were affected in t both meteor and classic (Fig. 1).

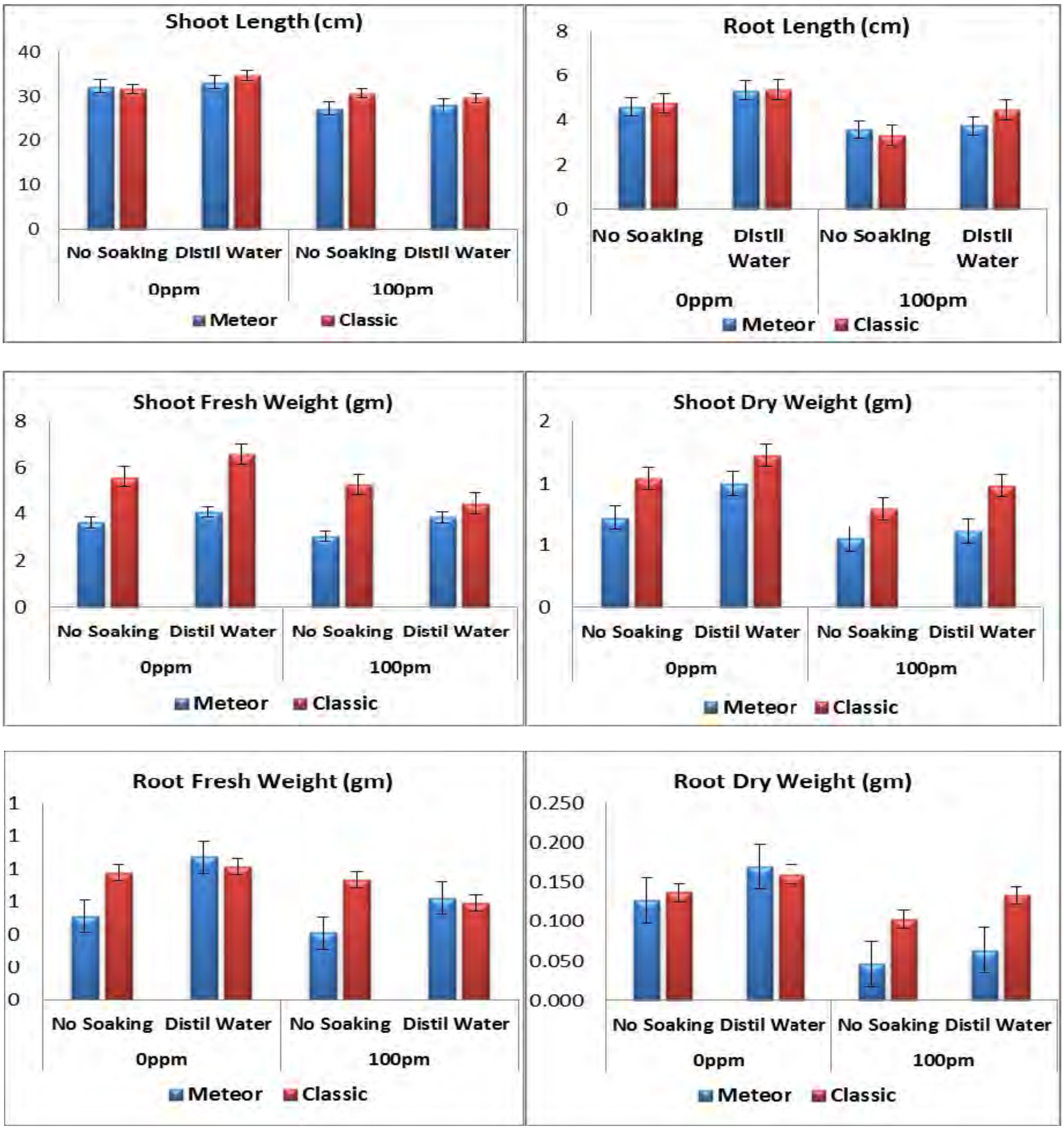


**Fig. 1** Effects of lead stress on the morphological characters of two pea varieties, meteor and classic.

One thing was impressive as presoaking of seeds in distil water before sowing was not only accelerating the values of those vegetative characters but also depressing of lead stress in both cultivars. Again lead stress in the form of 100 ppm of $Pb(NO_3)_2$ were found deteriorating the reproductive characters as pods per plant, seeds per plant and weight of 100 seeds per plant like vegetative characters and these crop yield aspects of pea were determined more roughly treated by lead in meteor than classic. In addition, pre-sowing treatment of seeds with distil water gave plants a way to stand against stress (Fig. 2).

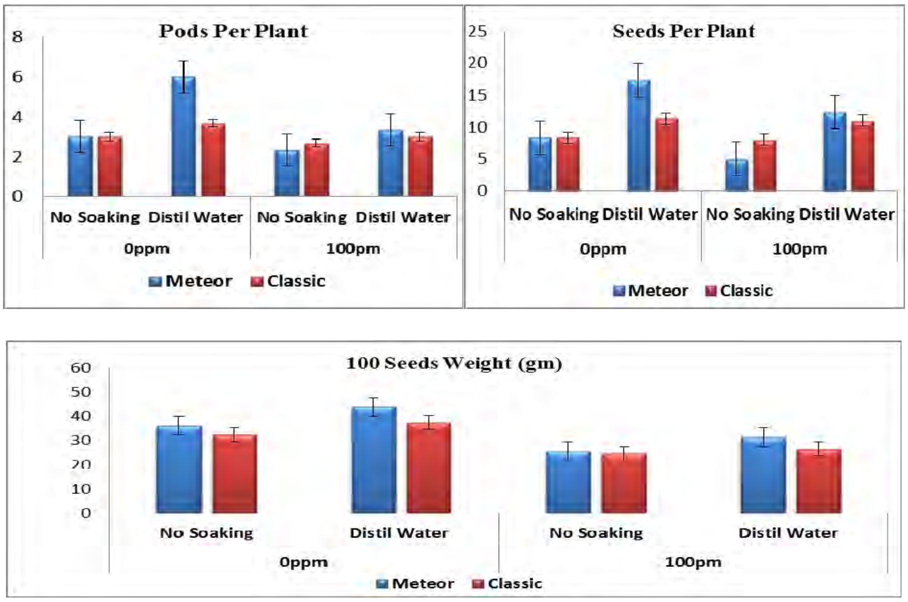


**Fig. 2** Effects of lead stress on economical characters of two pea varieties, meteor and classic.

Biochemical analyses of different antioxidants viz anthocyanin, flavonoids, ascorbic acid, hydrogen peroxides and phenolic were determined in all levels of lead stress (Fig. 3).

Moreover, seed priming with distil water was found be more beneficial as it was enhancing those antioxidants more than in plants without soaking (Fig. 3). The objective of this project was to highlight the impacts of lead stress on the agricultural and non-agricultural yields of pea varieties i.e. meteor and classic and vegetative features of both varieties were harmed by 100 ppm lead nitrate treatment. This lead stress also de-promoted in quantities the inflorescence related characters of peas. Both strains of pea, meteor and classic increased their stress defensive antioxidants. Preliminary treatment of seeds with distilled water for overnight made plant not only good against to facilitate them fight against stresses like heavy metals and also became a good strategy to increase the agronomic characters. In regard of above mentioned account it is considered that valuable vegetables which are vulnerable not only to natural stresses e.g. drought, salinity and waterlogging etc. but also to humanly generated stress like heavy metals etc. are challenging their quantitative and qualitative yields. Accumulation of the heavy metals in pea plants and other vegetables would be a source of many human disorders. It is recommended that experimental curies should be made to avoid the heavy metal uptake by pea plants by genetic engineering techniques and physiological and biochemical based preliminary applications should be discovered to assist plants in their immune mechanisms against stresses.

## 4 Conclusions

Lead nitrate ($Pb(NO_3)_2$) was damaging towards vegetative, propagative and physiochemical characters of pea. Chemical analyses of pea plants declared that pea plants activated their defensive chemical mechanisms by producing antioxidants against lead treatment and reduced its nutritive chemicals.

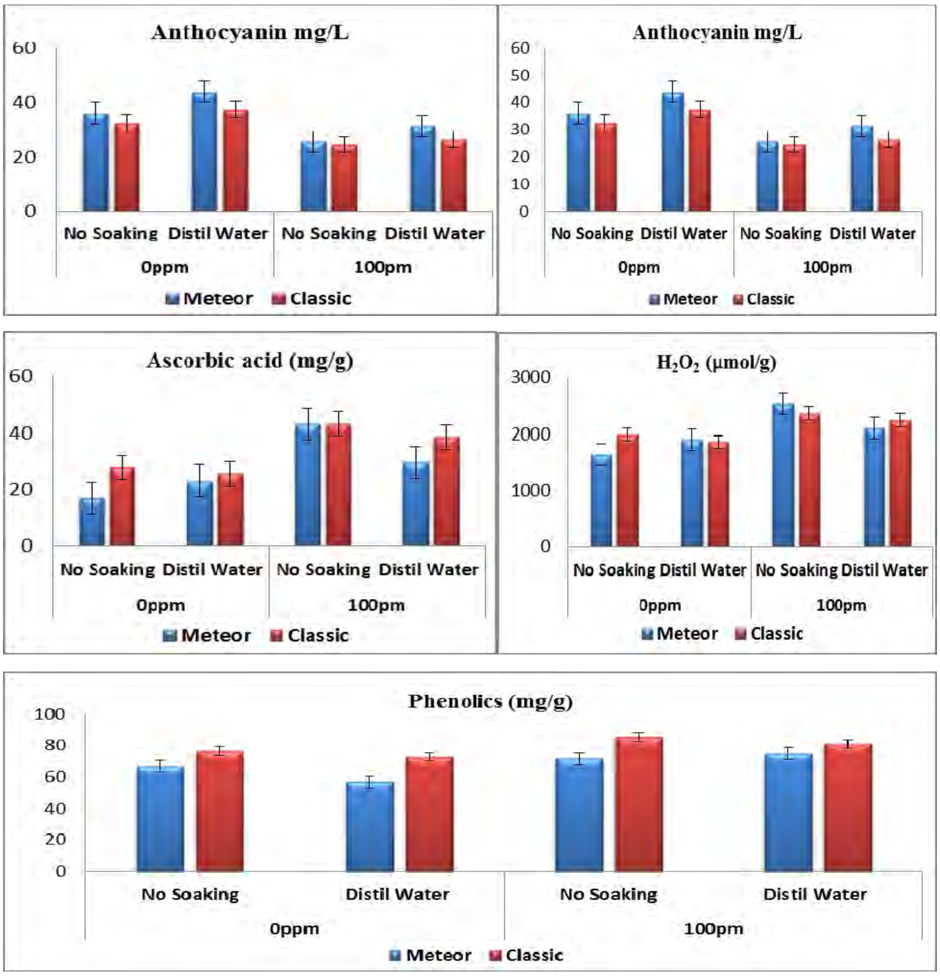


**Fig. 3** Effects of lead stress on different antioxidants of two pea varieties, meteor and classic.

## References

Abbas M, Parveen Z, Iqbal M, et al. 2010. Monitoring of toxic metals (cadmium, lead, arsenic and mercury) in vegetables of Sindh, Pakistan. Kathmandu University Journal of Science, Engineering and Technology, 6: 60-65

Acikgoz E, KatkatV, OmerogluS, et al.1985. Mineral elements and amino acid concentrations in field pea and common vetch herbages and seeds. Journal of Agronomy and Crop Science, 55: 179-185

Ahmed S, Waheed S, Mannan A, et al. 1994. Evaluation of trace elements in wheat and wheat by-products. Journal of AOAC, 77: 11

Aslam M, Mahmood IA, Sultan T, et al. 2000. Inoculation approach to legume crops and their production assessment in Pakistan-A Review. Pakistan Journal of Biological Sciences, 3(2): 193-195

Baryla A, Carrier P, Franck F, et al. 2001. Leaf chlorosis in oilseed rape plants (*Brassica napus*) grown on cadmium-polluted soil: causes and consequences for photosynthesis and growth. Planta, 212(5-6): 696-709

Bhutto MA, Zahida P, Sajid I, et al. 2009. Monitoring of heavy and essential trace metals contents in wheat procured from various countries by the Government of Pakistan in the year 2008-09. International Journal of Biology and Biotechnology, 6(4): 247-250

Clemens S. 2006. Toxic metal accumulation, responses to exposure and mechanisms of tolerance in plants. Biochimie, 88(11): 1707-1719

Delbari AS, Afsordeh B, Aghaee E. 2019. Cadmium and lead absorption in soil and plants of *Cercis siliquastrum* and *Ailanthus altissima*. Proceedings of the International Academy of Ecology and Environmental Sciences, 9(4): 149-158

Hu Y, Liu X, Bai J, et al. 2013. Assessing heavy metal pollution in the surface soils of a region that had undergone three decades of intense industrialization and urbanization. Environmental Science and Pollution Research, 20(9): 6150-6159

Jia ZS, Tang MC, Wu JM. 1999. The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals. Food Chemistry, 64(4): 555-559

Kim YY, Yang YY, Lee Y. 2002. Pb and Cd uptake in rice roots. Physiologia Plantarum, 116(3): 368-372

Kubo H, Peeters AJ, Aarts MG, et al. 1999. Anthocyaninless, a homeobox gene affecting anthocyanin distribution and root development in Arabidopsis. The Plant Cell, 11(7): 1217-1226

McKenzie DB, SpoonerD. 1999. White lupin: An alternative to pea in oat-legume forage mixtures grown in New Foundland. Canadian Journal of Plant Science, 79: 43-47

Morsy AA, Salama AHK, Kamel AH, et al. 2012. Effect of heavy metals on plasma membrane lipids & antioxidant enzymes of *Zygophyllum* species. Euro Asian Journal of BioSciences, 6: 1-10

Mukherjee SP, Choudhuri MA. 1983. Implications of water stress-induced changes in the levels of endogenous ascorbic acid and hydrogen peroxide in Vigna seedlings. Physiologia Plantarum, 58(2): 166-170

Nriagu JO. 1978. Biogeochemistry of Lead in the Environment. Elsevier/North-Holland Biomedical Press, 1: 137-183

Oram PA, Agcaoili M. 1994. Current status and future trends in supply and demand of cool season food legumes. In: Summerfield RJ. eds., World Crops: Cool Season Food Legumes. 3-49, Kluwer Academic Pub. Dordrech, Netherlands

Rasheed R. 2009. Salinity and extreme temperature effects on sprouting buds of sugarcane (*Saccharum officinarum* L.): Some histological and biochemical studies. PhD Thesis. Department of Botany, University of Agriculture, Faisalabad, Pakistan

Shan K, Kumar RG, Verna S, et al. 2001. Effect of cadmium on lipid peroxidation, superoxide anion generation and activities of antioxidant enzymes in growing rice seedlings. Journal of Plant Science, 161: 1135-1144

Sharma P, Dubey RS. 2005. Lead toxicity in plants. Brazilian Journal of Plant Physiology, 17: 35-52

Tudoreanu L, Phillips CJC. 2004. Empirical models of cadmium accumulation in maize, rye grass and soya bean plants. Journal of the Science of Food and Agriculture, 84: 845-852

Vassilev A, Lidon F. 2011. Cd-induced membrane damages and changes in soluble protein and free amino acid contents in young barley plants. Emirates Journal of Food and Agriculture, 23: 130-136

Velikova V, Yordanov I, Edreva A. 2000. Oxidative stress and some antioxidant systems in acid rain-treated bean plants: protective role of exogenous polyamines. Plant Science, 151(1): 59-66

Yadav SK. 2010. Heavy metals toxicity in plants: An overview on the role of glutathione & phytochelatins in heavy metal stress tolerance of plants. South African Journal of Botany, 76: 167-179