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Research Article

THE INFLUENCE OF LEAD ON GROWTH AND STOMATA STRUCTURE OF PIGEON PEA (*CAJANUS Cajan* (L.) MILLSPAUGH) AND MAIZE (*ZEA mays l.*)

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ABSTRACT

The investigation of the present study is to determine the effect of heavy metal lead (Pb) exposure on the morphology (growth measurement) and the changes of stomatal structure of Pigeonpea (*Cajanuscajan* (L.) and Maize (Zea mays L.) in the selected agriculture fields near Venellepalem village, Parvadamandal, Visakhapatnam district. The result of the study reveals that the growth of the plant is significantly reduced when compared with the control with increasing Lead concentration. The Scanning Electron Microscopic (SEM) studies showed changes in stomatal structures of the 10th leaf of both control, T1 and T2 areas of the two crop plants.

INTRODUCTION

The presence of heavy metals in soils may be beneficial or toxic to the environment. The high content of metals to be produced some common effects on macro and micro flora of different plants. Lead is one of the most, abundant, toxic and frequently encountered pollutant (Shahid *et al*., 2011, Bharwana *et al*., 2014).The lead contaminated media to land by the sewage, sludge, fertilizers and insecticides (Sammut *et al*., 2010, Austruy *et al*., 2014). The environment contaminated by the process of mining, smelting, combustion of gasoline, automotive exhaust fumes, effluents industries such as paints, paper, pulp, storage batteries, alloys, solder, ceramics, plastics, petrol refining, halogenations, extraction, sulphonation, manufacture of pigments, insulation cables, household wiring, printing inks, glass.

Lead contaminated soils show a sharp decline in crop productivity. Scientists have done extensive work on the morphological and physiological impact of Pb in plants and evaluated toxic effects on the different aspects such as, productivity and yield (Hussain *et al*. 2006, Zhang, 2017); growth tolerance index (Wojas *et al*. 2007); leaf area (Nosalewicz *et al*. 2008); root, shoot and leaf fresh biomass (Krystofova *et al*. 2009); inhibition of root elongation (Ghani *et al*. 2010); plant height (Farooqi *et al*. 2011); dry biomass (Yasin Ashraf *et al*. 2016, Azad 2011); induction of leaf chlorosis (Miller *et al*. 2011)etc. High concentration of Pb eventually may lead to cell death (Seregin and Ivanov 2001).Stomata play an important role in regulation of plant water balance and gas exchange. Stomatal parameters can be used as a stressful condition sign. Changes can be seen in stomata density and size depending on stress. (Wilkinson and Davies, 2002).Pigeon pea - C3 plant (*Cajanuscajan* (L.) Millspaugh) and Maize - C4 plant (*Zea mays* L.) is the most important food crops after rice and wheat in India. The Visakhapatnam is one of the most important industrial area in Andhra Pradesh. Due to urbanization, industries and pharmaceutical companies are developed near by the agriculture areas in this area. With the industrial development, the production and emission of heavy metals have increased. The nature of heavy metals to bioaccumulate causes toxicity in biological systems such as humans, animals, microorganisms and plants. The soil is contaminated by heavy metals is a major ecological concern due to its widespread release from agriculture, human activities and industry (Valko *et al*., 2005). Accumulation of heavy metals can reduce soil quality, crop yield and the quality of agricultural products. The aim of this study is to evaluate the effect of Pb in two different crop plants were investigated in relation to growth and Stomatal variations.

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MATERIALS AND METHOD

Study area

In the present study two different crops (Pigeon pea and Maize fields) were taken that is industrial area of Venellapalem village, Parawadamandal in Visakhapatnam. Which is located approximately Latitude: 17^0 30' 33" to $17^0$31' 48" North and Longitude: 82^0 57' 48" to 82^0 59' 35" East and the Botanical Research farm, Andhra University is located in Hanumanthawaka junction near kailasagiri hill station which was located approximately Latitude: $17^0$42" North and Longitude: $83^0$17" East.

Sample Collection

The experiment was carried out in three sites during the study period 2015 to 2017. The T1 field area was 5 Kilometre (Km), T2 field area 1 Km near by industry and the control area C Botanical Research farm, Andhra University shown in the table1.

Growth Measurements

The certified seeds of Pigeonpea (*Cajanuscajan* (L.) Millspaugh) and Maize (*Zea mays* L.) were obtained from International Crops Research Institute for the Semi–Arid Tropics, Hyderabad. The Seeds of Pigeon pea and Maize were washed thoroughly under running tap water and finally with distilled water before sowing and applied to the three sampling areas.

Based upon the growth rate, the data of the ten plants were collected from each field to observe the growth.

SEM Studies

The 10^{th}leaf of each plant in three different fields was collected for scanning electron microscopic studies. The epidermal surface was studied with SEM microscope (JEOL JFC-1600) for which the samples were covered by gold. Then scanned the samples under Scanning Electron microscope (Model: JEOL-JSM6610LV) at various magnifications.

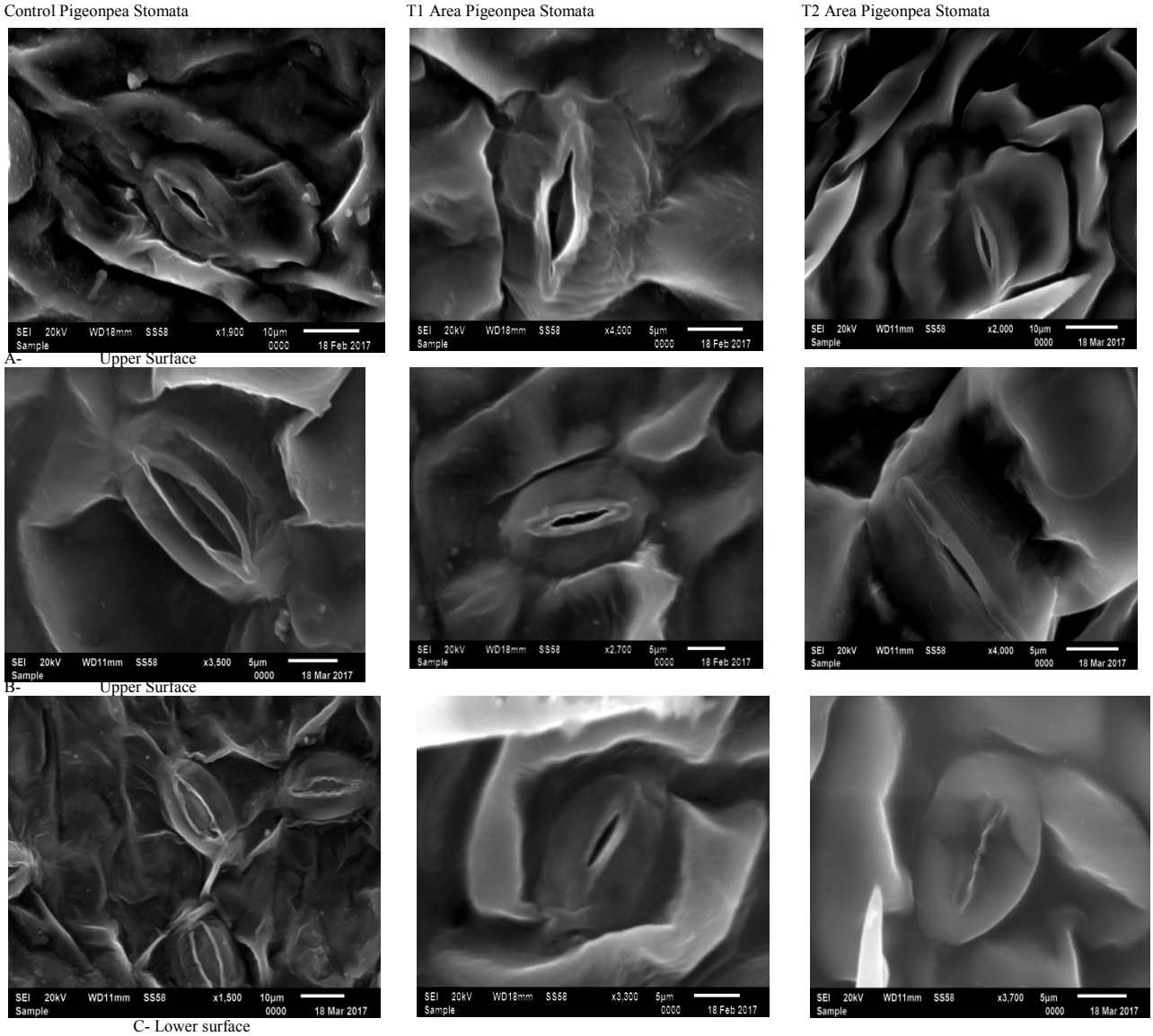

Figure 1 Scanning Electron Microscopic Images of *Cajanus cajan* (L.) Millspaugh leaves in control and Tested field areas (A & B- Upper Surface, C- Lower Surface for C,T1 &T2).

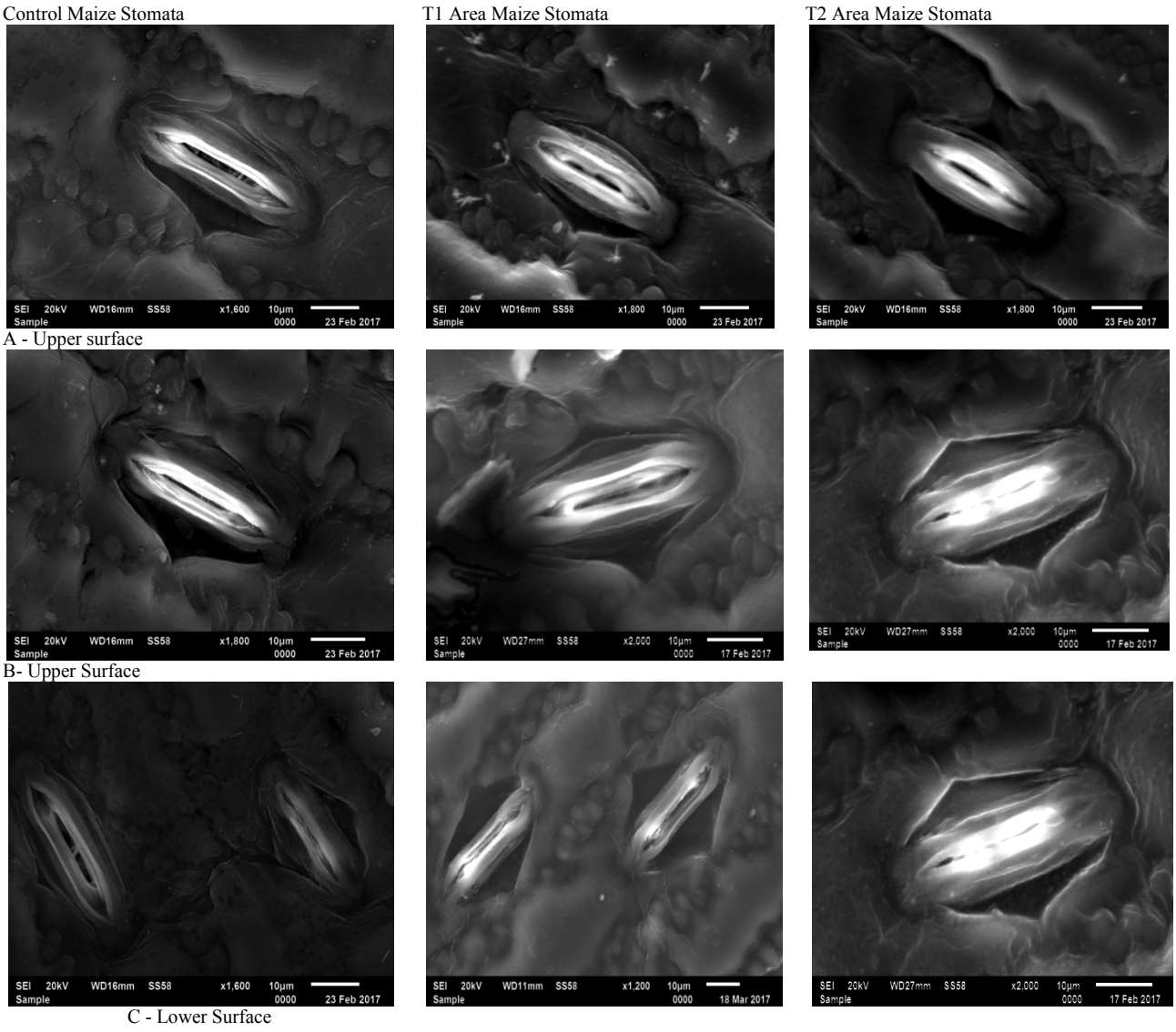

Figure 2 Scanning Electron Microscopic Images of *Zea mays* L.in in control and Tested field areas (A & B- Upper Surface, C- Lower Surface for C,T1 &T2).

Source of error

Uprooting the plants at the beginning of each experiment presumably disturbed the roots of neighbouring plants. An unavoidable source of error in growth studies on field crops is that the whole root system cannot be recovered. Even though, the plants were carefully removed from the field, some delicate root portions were occasionally broken-off.

RESULTS AND DISCUSSION

In the present study observed, that the concertation of lead ranged from 12.360 to 17.133 mg/kg in T1,T2 and Control areas. According to (Divya Jyothi and Sujatha, 2017) reported that the high level of lead effect on seed germination on crop plants.

Table 1 Growth Measurements of Study Area

	T1 Field Area		T2 Field Area		Control Area	
	Pigeonpea	**Maize**	**Pigeonpea**	**Maize**	**Pigeonpea**	**Maize**
After Flowering	268.51cm	270.30cm	206.61cm	218.89cm	360.36cm	345.30cm

The growth analysis data were observed in controlled field area as well as in T1 and T2 areas. In controlled field area, the plants with an initial slow growth up to 30 days and followed by a rapid increase in two crop plants. In the T1 and T2 area the growth of the plants was very slow when compared to control area. After flowering, the growth pattern will increase and the plant reaches up to maximum plant height shown in the given table no 1.

There is a significance of reduction in growth rate in both contaminated areas with increasing lead concentration was recorded when compared to their controls. Lead contaminated soils show a sharp decline in crop productivity. Scientists have done extensive work on the morphological and physiological impact of Pb in plants and evaluated toxic effects on the different aspects such as, plant height (Farooqi *et al*. 2011). Results from multiple studies demonstrate that the plant by plants are significantly affected by the presence of Lead (Gopal and Rizvi 2008; Zhong, 2017).

Scanning Electron Microscopic Studies

The scanning electron microscopic studies of the stomata were carried out on10th leaf of both controlled, T1 and T2 areas of the two crop plants. In the controlled area the stomata of the 10th leaf of both crop plants was fully grown with the well-developed borders and ledges. In the T1 area with defective, abnormal, small and undeveloped stomata with narrow stomatal pore. The leaves were undeveloped with partially opened and closed stomata was observed in the T2 area. The result of SEM images was shown in Fig.1 and 2.

Stomata play an important role in regulation of plant water balance and gas exchange. Stomatal parameters can be used as a stressful condition. Changes can be seen in stomata density and size depending on stress. (Wilkinson and Davies, 2002). There is insufficient information about the response of Pigeon pea and Maize crop plants in Pb exposure under field conditions.

CONCLUSION

The result concluded that the reduction in growth rate in both contaminated areas with increasing lead concentration was recorded when compared to their controls. In two crop plants the physiological (SEM) studies for stomatal apparatus, structure and behaviour were more affected by lead (Pb). The contaminated areas of T1 and T2 are exposure to toxic levels of lead (Pb). Finally, this research work is a significant reference for future studies of these areas and other regions as well.

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