Effects of aluminum on antioxidant enzymes in leaf senescing rice variety
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ABSTRACT: Aluminum is widely distributed element in the earth crust. There exists possibilities of accumulation of aluminum in rice leaves also especially under acidic soils conditions. Hence the author aimed to study the effect of aluminum in senescing rice leaves i.e. ADT 43 and PA 6129 varieties on exposure to different of concentrations of aluminum at different exposure periods. In our study we estimated activities of peroxidase, catalase, Superoxide dismutase and ascorbic acid oxidase. Results exhibited that a significant increase was found in the activities of peroxidase, catalase and ascorbic acid oxidase in ADT 43 and PA 6129 varieties on exposure to aluminum. Further the degree of increase was found to be dependent on duration of exposure. Further degree of elevation in enzyme activity was relatively higher in aluminum cultivar ADT 43 when compared to cultivar PA 6129. The results were discussed in light of current literature. On the whole, cultivar ADT 43 exhibited aluminum tolerance.

Keywords: Antioxidant enzymes, rice, Aluminum toxicity, leaf senescence.

INTRODUCTION
The Aluminum toxicity limits plant productivity in acid soils (Kochian, 1995; Vitorello et al. 2005). This element dominates affects upto 25% of the soils in India. Many crops reacted as serious constraint due to sensitive i.e., cereals by optimal exchange of alumina. Aluminum accumulates in the root apex that inhibits the root elongation and cell division (Kochian, 1995; Arroyave et al., 2011). The toxic levels of Al are able to modify plant metabolism and changes in the redox state of cellular components that are induced Reactive oxygen species (ROS) production, finally resulting in the generation of oxidative stress (Ma et al., 2012). Hence, in this study, we studied the responses of Al induced oxidative stress in two rice variety in the antioxidant systems during leaf senescence.

Materials and Methods
Rice (Oryza sativa .L) seeds of two varieties i.e., ADT 43 and PA 6129 were procured from PKKVK, Pondicherry India. Eight weeks old rice leaves from plants were grown in field conditions; in this photosynthetic part was used for further studies. 7 cm leaf bits from fully expanded and matured leaves were washed in distilled water. Four leaf bits were placed in petridishes of 20 cm diameter. The petridishes were kept in light and dark periods (48, 96, 144, 192 hrs) as per the standard protocols. The biochemical analysis was carried after at different periods of exposures and at different concentrations (100µM, 200µM, 300 µM). Petri dishes were kept under light intensity of approximately 150wm-2 and temperature of 27°±3°C of incubation.

RESULTS
Catalase
From the Fig.1 it is seen that the catalase activities decreased in aluminum exposed rice leaves, relative to controls the Catalase activity was significantly decreased at all concentrations in both cultivars. However, the decrease in Catalase was greater in magnitude in PA 6129 than in ADT 43 at all the concentrations of aluminum on all days of exposure.

Fig.1: Percent decrease over control in the Catalase in the leaves of rice varieties of control and on exposure to different concentrations of aluminum at 2, 4, 6 and 8 days
**Guaiacol Peroxidase**

From the data presented in the fig. 2 it is seen that relative to controls peroxidases activity was increased in the leaves of aluminum exposed rice leaves. Peroxidases activity increased significantly in both PA 6129 and ADT 43. Further guaiacol peroxidases activities increased significantly in both cultivars at concentrations and at all exposure days. However, the percent increase in the activity was more in the cultivar PA 6129 than in ADT 43.

![Fig.2: Percent increase over control in the Guaiacol peroxidase in the leaves of rice varieties of control and on exposure to different concentrations of aluminum at 2, 4, 6 and 8 days.](image)

**Ascorbate oxidase**

Ascorbate oxidase activity in the leaves was presented in the fig. 3, the Ascorbate oxidase activities levels significantly increased at all the concentrations of aluminum exposure in both PA 6129 and ADT 43. The Ascorbate oxidase activities were significantly increased by all days of exposure. Furthermore, the degree of increase was dependent on concentration of exposure period. The shifts in Ascorbate peroxidase were greater in ADT 43 than in PA 6129 cultivars.

![Fig.3: Percent increase over control of Ascorbic acid oxidase in the leaves of rice varieties on exposure to different concentrations of aluminum at 2, 4, 6 and 8 days.](image)

**DISCUSSION**

Enzymatic anti oxidative defense system includes Catalase, Guaiacol peroxidase and ascorbate oxidase. With increasing levels of aluminum treatment a concomitant decline in catalase activity was absorbed in leaves of rice at all exposure periods. Compared to ADT 43 rice variety, a greater inhibition in catalase activity was observed in PA 6129 cultivars. Our results showed a decrease in the level of catalase activity indicating that aluminum inhibits catalase activity. Our results are in conformity with the observations of many other investigators who have also found that aluminum inhibited of catalase activity (Beers, 1955). Agner and Theorell (1946) concluded that iron atoms of the catalase have hydroxyl groups that may be replaced by low molecular weight anions, in sufficient concentrations, such that catalase is correspondingly inhibited. However, the aluminum in vivo may be causing a reduction in the amount of catalase erase and not just a simple inhibition of the catalase system as measured in the homogenates.

The present study indicated that an enhancement in the activity of guaiacol peroxidase suggesting that this enzyme serves as an intrinsic defence tool to resist aluminum induced oxidative damage in rice leaves guaiacol peroxides is widely accepted as stress enzymes (Gaspar et al 1991). In this study, a stress intensity dependendent increase in guaiacol peroxidase activity in both genotypes was observed. However the activity was relatively greater in ADT 43 compared to Pa 6129. The higher activity of guaiacol peroxidase was observed in ADT 43 under aluminum exposure. Ascorbic peroxidase along with catalase and super oxide dismutases are considered as key enzymes within the antioxidative defense mechanism, which directly determine the cellular concentration of O2 and H2O2 (Asada, 1992).

The present study, suggest that aluminum toxicity causes oxidative stress in rice leaves and the enzymes guaiacol peroxidase appear to play a key role in counteracting the oxidative stress in plants. As, unlike iron, aluminum is not an oxido-reducing metal, the oxidative stress induced by aluminum in the leaves of rice appears to be an indirect effect of aluminum toxicity leading to production of reactive oxygen species with simultaneous increase in tissue levels of peroxidases.

**CONCLUSION**

On the whole it may be concluded that aluminum enhance the onset of many of the physiological and biochemical changes which are generally associated with natural aging and senescence in rice leaves. It also suggests that these changes occur at faster rate in cultivar PA 6129 than in ADT 43 and the leaf senescence was more hastened.
by increasing concentration of aluminum over a period of exposure.

REFERENCES