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Leaf Photochemical Activity and Antioxidant Protection in Selected Hill Rice Genotypes of Koraput, India in Relation to Aluminum (Al^{3+}) Stress

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Genetic variation for Aluminum (Al^{3+}) tolerance is prerequisite for developing cultivars with improved tolerance to Al^{3+} stress. The present study aims to assess genotypic variability of growth, photosynthesis along with antioxidant defense in popular hill rice landraces of Koraput, India under different concentrations of Al^{3+} and compare the responses with modern rice varieties to identify Al^{3+} tolerant rice genotypes. After exposure to different level of Al^{3+}, the growth parameters such as shoot length, root length, fresh and dry weight of rice seedlings were significantly ($P<0.05$) inhibited in the studied genotypes compared to the control seedlings. Significant ($P<0.05$) reduction in SPAD index, chlorophyll and carotenoid content was observed in all rice seedlings under high concentration of Al^{3+}. Higher concentration of Al^{3+} also alters the photo system (PS) II activity, as revealed in the reduction in the values of maximal fluorescence (Fm), maximum photochemical efficiency of PSII (Fv/Fm), yield of photochemical efficiency [Y(II)] and photosynthetic quenching (qP) with concomitant increase of minimal fluorescence (Fo) and non-photosynthetic quenching (NPQ). The antioxidant enzymes activities such as superoxide dismutase, ascorbate peroxidase and guaiacol peroxidase were increased in rice seedlings under elevated Al^{3+} concentrations. Taken together, hill rice landraces namely; Kalajeera, Machakanta, Haladichudi showed superior photochemical activity and better antioxidant protection than that of IR 64 cultivar. These hill rice landraces are identified as potential donors for the Al^{3+} tolerance breeding program.

Key words: Antioxidant enzymes, Al3+ tolerance, chlorophyll fluorescence, traditional rice

Aluminum (Al^{3+}) toxicity is a major constraint for low rice productivity in acidic soil worldwide (Guo *et al.*, 2012; Hoekenga *et al.*, 2003). About 30% of global land and more than 50% of potential land suitable for cultivation are acidic and prone to Al^{3+} stress (Kochian *et al.*, 2004). Rice is found to be the most Al^{3+} tolerant cereal crop in compared to rye > wheat > barley under field conditions (Foy, 1988). Considering the existence of huge genetic variability within the rice genotypes for Al^{3+} tolerance, considerable scope is available to exploit the same for the development of tolerant cultivar. However, the mechanism of Al^{3+} tolerance in rice is not fully understood and phenotyping for Al^{3+} tolerance continue to remain as an important pre-requisite for rice breeding programs.

The inhibition of root and shoot growth as well as plant biomass is the most important symptom of Al^{3+} toxicity (Huang *et al.*, 2012). It is one of the vital factors that affect photosynthesis in terms of CO_2 fixation, electron transport, photophosphorylation and enzyme activities (Simon *et al.*, 1994). However, it is not fully understood as to what extent Al^{3+}-induced inhibition of photosynthesis and PSII activity, since sufficient information on the photosynthetic response of rice plant and its photosynthetic apparatus to different levels of Al^{3+} is not available. When plants are subjected to Al^{3+} stress, different reactive oxygen species such as H_2O_2, OH^- and O_2^- are produced and damage DNA, proteins and pigments as well as causes lipid peroxidation (Panda, 2007; Panda and Choudhury, 2005). However, plant possesses various antioxidative enzymes such as superoxide dismutase, catalase and peroxidase to avoid this kind of cellular damages by scavenging the produced ROS (Zhang *et al.*, 2010). A few information is available on Al^{3+} induced oxidative stress in higher plants compared to other metals. More over the relationship of photosynthesis with antioxidant defense in rice plant under Al^{3+} stress is not known so far.

Koraput is one of the tribal dominated districts is extensively forested and is characterized by scattered, sharp and isolated hills with large amount of Bauxite deposits. This region is popularly known as secondary centre of origin of Asian cultivated rice and home to large number of hill rice landraces (Mishra *et al.*, 2012). Due to high mineral deposits, many types of rice landraces are adapted for cultivation by the local farmers suited to the agro climatic condition. A high level of genetic diversity was found in the local rice landraces and contains a number of favorable genes, which helps the rice genotypes to overcome biotic and abiotic stresses (Prashanth *et al.*, 2002; Vikram *et al.*, 2016). As a corollary, sufficient phenotypic knowledge as well as profiling reports of these local rice landraces of Koraput with regard to Al^{3+} tolerance is not available.Therefore, the present study is to assess genotypic variability of growth, photosynthesis coupled with antioxidant defense in selected hill rice genotypes under different concentrations of Al^{3+} and compare the responses with modern rice varieties to identify Al^{3+} tolerant rice genotypes with a higher physiological efficacy.

MATERIALS AND METHODS

Plant material and growth conditions

Three different hill rice landraces such as *Kalajeera, Machakanta* and *Haladichudi* from Koraput, India along with one modern rice genotype (IR 64) was used for the study. The rice seeds were obtained from MS Swaminathan Research Foundation (MSSRF), Koraput. Dry healthy seeds of each variety were sort out and treated with 0.1% mercuric chloride ($HgCl_2$) for five minutes followed by thorough wash with distilled water for three times. Thereafter the seeds of each genotype were kept over saturated tissue paper, firmly placed in sterilized petriplates and regularly irrigated under varying concentrations of Al^{3+} (0 as control, 100 µM, 200 µM, and 300 µM) [source: $AlCl_2$] at 25 °C in the laboratory condition. The plants are maintained for 15 days in 400 ± 20 µMol m^{-2} s^{-1} photon flux density with 70 ± 5% relative humidity. The experiment was carried out in three replications with randomized block design.

Plant growth parameters

The plant growth characteristics were examined after 15 days of Al^{3+} treatment (in each concentration) by measuring the plant height, root length, fresh and dry weight of five different plants in each replication. After oven drying the samples at 80 °C the dry weight was recorded.

Measurement of leaf photochemical activity

Leaf photochemical activity was measured in dark- and light-adapted leaves using a portable chlorophyll fluorometer (JUNIOR-PAM, WALZ, Germany). Chlorophyll fluorescence parameters such as minimal fluorescence (Fo), maximal fluorescence (Fm), maximum photochemical efficiency of PSII (Fv/Fm), yield of PSII photochemistry (Y II), non-photochemical dissipation of absorbed light energy (NPQ) and the coefficient for photochemical quenching (qP) was measured and calculated following Maxwell and Johnson, (2000).

Measurement of chlorophyll, carotenoid content and chlorophyll index

The leaf pigment content was estimated by keeping 50 mg of finely chopped fresh leaves in a tightly capped 25 ml ria-vial containing 5 ml cold acetone (80%). Then the vials were placed in dark condition to prevent degradation of chlorophyll for 48 h at 4°C. The total chlorophyll and carotenoid contents were calculated using the equations of Porra, (2002) and Nayek *et al.*, (2014) respectively. Chlorophyll index were measured on different plants of each treatment condition using an SPAD 502 chlorophyll meter (KONIKA MINOTA SENSING, JAPAN).

Measurement of antioxidant enzyme activity and protein content

Fresh leaf samples (500 mg) of each treatment were homogenized in 10 ml of 50 mM potassium phosphate buffer (pH 7.8) which contains 1.0 mM EDTA, 1.0 mM ascorbate, 10% (w/v) sorbitol and 0.1% triton X-100. The homogenate was centrifuged at 15000 g for 20 min and the supernatant was used for enzyme analysis. All these operations were performed at 0-4 °C. Aliquot of the extract was used to estimate protein content following Lowry *et al.*, (1951). Superoxide dismutase activity was measured using the photochemical method followed by Gianopolitis and Ries, (1977) with modifications suggested by Chowdhury and Choudhuri, (1985). Measurement of ascorbate peroxidase activity was according to Nakano and Asada, (1981) by monitoring the rate of ascorbate oxidation at 290 nm (E = 2.8 mM cm^{-1}). Catalase activity was measured following Cakmak and Marschner, (1992) by monitoring the decomposition of H_2O_2 at 240 nm for one minute. The activity of guaiacol peroxidase was assayed following the method of Rao *et al.*, (1995) by oxidation of guaiacol at 470 nm (E = 26.6 mM cm^{-1}).

Statistical analysis

Different physiological parameters were analyzed by analysis of variance (ANOVA) using CROPSTAT software (International Rice Research Institute, Philippines).

RESULTS

Plant growth and early seedling vigor exposed to different concentration of Al^{3+}

The shoot and root length were not significantly ($P<0.05$) different among the rice genotypes in control condition but showed significant ($P<0.05$) reduction with increasing concentration of Al^{3+} treatments (Table 1). After treating with 100 µM of Al^{3+}, the shoot and root length were decreased by 20% and 50% in *Machakanta* and 10% each in *Haldichudi*, respectively compared to control plant. Similarly, fresh and dry weight of different rice seedlings were not significantly ($P<0.05$) changed among control plants but significant ($P<0.05$) reduction was noticed under 100 µM, 200 µM and 300 µM of Al^{3+} treatments (Table 1). The decrease was more pronounced in the studied hill rice genotypes compared to modern high yielding cultivar IR 64 under different Al^{3+} treatments.

SPAD chlorophyll index, chlorophyll (Chl) and carotenoid content

The SPAD Chl index of rice seedlings ($P<0.05$) were not significantly different in control plants but different concentration of Al^{3+} remarkably declined the SPAD index in all the rice varieties. The percentage of reduction of SPAD index in studied rice genotypes was 48-58% under 300 µM of Al^{3+} (Table 2). Similarly varietal difference of leaf Chl and carotenoid content were not observed under control condition but significantly ($P<0.05$) decreased under Al^{3+} treatments. Further, leaf protein content was increased in *Machakanta* and *Haldichudi* under 300 µM of Al^{3+} compared to their respective control but in *Kalajeera* and IR 64 the protein content was un-changed (Table 2).

Chlorophyll fluorescence parameters in rice seedlings

The leaf PSII activity in rice seedlings was carried out by measurement of various chlorophyll fluorescence parameters under different Al^{3+} treatments and presented in Table 3. Maximum fluorescence (Fm) and maximum photochemical efficiency of PSII (Fv/Fm) was noticeably reduced ($P<0.05$) with increase of Al^{3+} concentration compared to control plants. Higher concentration of Al^{3+} (300 µM) declined the Fm and Fv/Fm value and more inhibition of value was observed in IR 64. Higher levels of Al^{3+} (300 µM) also declined the quantum yield of PSII photochemistry [Y (II)] and photochemical quenching (qP) in all the rice genotypes but resulted in increase in non-photochemical quenching (NPQ) and minimum fluorescence (Fo) level (Table 3).

Antioxidant enzyme activity in rice seedling

The SOD activity was significantly ($P<0.05$) enhanced in all the indigenous hill rice genotypes such as *Machakanta, Kalajeera* and *Haldichudi* with increasing Al^{3+} levels (Fig. 1A). However, SOD activity was significantly ($P<0.05$) decreased in IR 64 (Fig. 1A). Similarly, APX activity was significantly increased in 100 and 200 µM of Al^{3+} but significantly ($P<0.05$) decreased under higher concentration of Al^{3+} (300µM) compared to control plants (Fig. 1B). The GPX activity was significantly ($P<0.05$) increased over control plants in all the hill rice genotypes with increasing Al^{3+} levels (Fig. 2A), whereas, less activity of GPX was recorded in IR 64 (Fig. 2A). The CAT activity was significantly decreased over the control plants in all the studied genotypes with increasing Al^{3+} levels (Fig. 2B).

DISCUSSION

Al^{3+} is one of the major constraints, which adversely affects the crop production as well as growth of the plant (Kochian, 1995; Pineros and Kochian, 2012; Yang *et al.*, 2008). The present study revealed that after exposure to different level of Al^{3+}, the length of shoot and root, fresh and dry weight of rice seedlings were significantly inhibited (Table 1). The root growth was more affected under Al^{3+} stress in all the genotypes. Similar results of inhibition of growth parameters in plants due to disturbances in cellular metabolism on the account of Al^{3+} toxicity was reported in rice as well as in other crops (Panda *et al.*, 2009; Panda *et al.*, 2003). The reduction of root and shoot growth might be due to inability of the roots to absorb nutrients and water (Shanker *et al.*, 2005). The main reason for the reduction of fresh and dry weight of rice plant is due to poor growth of shoot and root.

Photosynthetic pigments are sensitive parameter in metal stress conditions and they are taken as a potential biomarker for metal stress (Ma *et al.*, 2016). The remarkable reduction in SPAD index, chlorophyll and carotenoid content in all rice seedlings were observed under high level of Al^{3+}. This may be due to chlorophyll degradation by free radicals generated by metals as reported in rice by Ma *et al.*, (2016). The decrease of chlorophyll content under Al^{3+} stress may be due to inhibition of the enzymes involved in chlorophyll biosynthesis (Singh *et al.*, 2006) coupled with damage to chloroplast, ultimately cause the disturbances in photosynthetic capacity (Panda *et al.*, 2009). The reduction in carotenoid content was possibly due to Al^{3+} reduces size of the peripheral part of antenna complex that leads to degradation and destabilization of peripheral proteins (Shanker *et al.*, 2005).

To find out the alterations of PSII activity in rice seedlings under Al^{3+} stress, we used Chl fluorescence measurements in different treatments. Based on the results, higher level of Al^{3+} alters the leaf PSII activity, as evident in the decrease in the values of Fm, Fv/Fm, Y (II) and qP (Table 3). Fo is minimal fluorescence levels when all reaction centers of PSII are open (Calatayud *et al.*, 2006). Increase in Fo represents the degradation in PSII protein or any disruption in energy transfer into the reaction center (Calatayud *et al.*, 2006) and it reflects the photo-inhibition (Aro *et al.*, 1993). In the present study Fo is increased with the increase of Al^{3+} concentration and it reduced the photochemical capacity of PSII (Calatayud *et al.*, 2006). This may be due to the disorganization at the antenna pigment level (Calatayud and Barreno, 2001) or fall of chlorophyll content in the rice seedlings as noticed under Al^{3+} stress (Table 2). The Fv/Fm value is the ratio of variable fluorescence to maximal fluorescence and it measures the maximum efficiency of Photo system II (Murchie and Lawson, 2013). This value is useful for the estimation of the potential efficiency of PSII by taking dark adapted

measurements (Calatayud *et al.*, 2006). In this study with increase of Al^{3+} concentration, decreasing trend of Fm, Fv/Fm, qP, Y (II) was notice, which indicates the decreasing ability of PSII to reduce the primary acceptor Q_A (Mathur *et al.*, 2016). Like other abiotic stresses, Al^{3+} in high concentration also affects the photosynthetic apparatus and this may be due to photo-inhibition or other injury to PSII components in rice seedlings (Baker and Rosenquist, 2004). The NPQ in rice seedlings increases gradually with increase in Al^{3+} concentration suggests the decrease in the quantum efficiency of PSII photochemistry either by causing a decrease in the rate of primary charge separation or by increase of heat dissipation (Calatayud *et al.*, 2006).

The activities of antioxidant enzymes caused by Al^{3+} stress are considered to be important defense systems of plants against oxidative stress (Zhang *et al.*, 2010). Plants inherently contain various antioxidant enzymes that control the level and effects of ROS. In this study, the activities of SOD, APX and GPX were increased in rice seedlings under elevated Al^{3+} concentrations. The increased enzyme activities was due to the response to active oxygen activities caused by metal ion Al^{3+} or possibly, increased levels of active oxygen stimulate the cellular protective mechanism to mitigate damages (Bhaduri and Fulekar, 2012; Xu *et al.*, 2010). But in contrast CAT activity was decreased under high Al^{3+} concentration and CAT was more sensitive compared to other antioxidant enzymes under higher concentration of Al^{3+}. Aluminum tolerance among indigenous hill rice landraces was carried out by measurement of relative value of different physiological parameters under Al^{3+} stress and further, these parameters were compared with modern high yielding IR 64 variety. In the present study hill rice genotypes namely, *Kalajeera, Machakanta, Haladichudi* showed higher relative value of different parameters than that of IR 64 cultivar. It indicated that *Kalajeera, Machakanta, Haladichudi* as highly tolerant and showed the adaptive fitness to Al^{3+} stress and can be used for rice breeding program.

Table 1: Changes of growth parameters in 15 days old rice seedlings exposed to different concentration of Al3+. Data are the mean of three replications and relative value to the control is presented in bracket.

Variety	**Shoot length (cm plant^{-1})**				**Root length (cm plant^{-1})**			
	Control	**100µM**	**200 µM**	**300 µM**	**Control**	**100µM**	**200 µM**	**300 µM**
Machhakanta	10.7(1)	8.8(0.8)	9.8(0.9)	9.0(0.8)	10.9(1)	6.3(0.5)	4.9(0.4)	6.1(0.5)
Haldichudi	10.6(1)	11.3(1.1)	10.3(0.9)	9.6(0.9)	8.5(1)	8.1(0.9)	10.7(1.2)	8.1(0.9)
Kalajeera	10.4(1)	8.9(0.8)	10.6(1.0)	8.5(0.8)	9.1(1)	4.9(0.5)	8.1(0.8)	5.5(0.6)
IR 64	11.7(1)	8.5(0.72)	7.2(0.61)	6.7(0.57)	9.6(1)	5.7(0.6)	8.3(0.8)	7.3(0.7)
LSD*P<0.05	1.05				1.58			
Variety	**Fresh weight (g plant^{-1})**				**Dry weight (g plant^{-1})**			
	Control	**100µM**	**200 µM**	**300 µM**	**Control**	**100µM**	**200 µM**	**300 µM**
Machhakanta	0.08(1)	0.06(0.7)	0.07(0.84)	0.06(0.6)	0.01(1)	0.01(0.8)	0.01(0.8)	0.011(0.9)
Haldichudi	0.11(1)	0.11(1.4)	0.12(1.40)	0.07(0.7)	0.013(1)	0.014(1.1)	0.014(1.1)	0.012(0.9)
Kalajeera	0.16(1)	0.10(0.6)	0.10(0.65)	0.08(0.5)	0.009(1)	0.011(1.2)	0.011(1.2)	0.009(1.0)
IR 64	0.20(1)	0.13(0.6)	0.11(0.5)	0.11(0.5)	0.018(1)	0.014(0.7)	0.014(0.7)	0.013(0.6)
LSD*P<0.05	0.002				0.0003			

Table 2: Changes of Chlorophyll, Carotenoid, protein and SPAD index in 15 days old rice seedlings exposed to different concentration of Al3+. Data are the mean of three replications and relative value to the control is presented in bracket.

Variety	**Chlorophyll(mg g^{-1}Fwt)**				**SPAD (rel.)**			
	Control	**100µM**	**200 µM**	**300 µM**	**Control**	**100µM**	**200 µM**	**300 µM**
Machhakanta	1.80(1)	1.75(0.97)	1.45(0.80)	1.25(0.69)	9.70(1)	7.50(0.77)	5.85(0.60)	5.05(0.52)
Haldichudi	2.80(1)	2.75(0.98)	1.35(0.48)	1.20(0.42)	8.85(1)	8.00(0.90)	9.35(1.05)	5.15(0.58)
Kalajeera	2.15(1)	2.10(0.97)	1.70(0.79)	1.00(0.46)	9.55(1)	6.25(0.65)	5.50(0.55)	4.05(0.42)
IR-64	3.30(1)	2.20(0.66)	1.50(0.45)	1.25(0.37)	10.9(1)	9.60(0.88)	4.80(0.44)	4.65(0.42)
LSD*P<0.05	0.428				1.70			
Variety	**Protein(mg g^{-1}Fwt)**				**Carotenoid (mg g^{-1}Fwt)**			
	Control	**100µM**	**200 µM**	**300 µM**	**Control**	**100µM**	**200 µM**	**300 µM**
Machhakanta	12.9(1)	14.8(1.14)	16.5(1.27)	14.7(1.13)	0.660(1)	0.530(0.80)	0.445(0.67)	0.330(0.5)
Haldichudi	15.2(1)	16.8(1.10)	17.0(1.11)	17.3(1.13)	0.800(1)	0.715(0.89)	0.360(0.45)	0.320(0.4)
Kalajeera	14.1(1)	16.8(1.19)	12.7(0.90)	13.8(0.97)	0.865(1)	0.560(0.64)	0.620(0.71)	0.365(0.42)
IR-64	22.7(1)	19.0(0.83)	22.2(0.97)	20.9(0.92)	0.975(1)	0.855(0.87)	0.560(0.57)	0.355(0.36)
LSD*P<0.05	4.35				0.144			

Table 3: Changes of leaf chlorophyll fluorescence parameters in 15 days old rice seedlings exposed to different concentration of Al3+. Data are the mean of three replications and relative value to the control is presented in bracket.

Variety	Fo (rel.)				Fm (rel.)			
	Control	**100µM**	**200 µM**	**300 µM**	**Control**	**100µM**	**200 µM**	**300 µM**
Machhakanta	270(1)	217(0.80)	244(0.90)	339(1.40)	1229(1)	1023(0.83)	1032(0.83)	1056(0.85)
Haldichudi	264(1)	266(1.07)	311(1.17)	342(1.29)	1290(1)	1209(0.93)	1110(0.86)	1011(0.78)
Kalajeera	268(1)	281(1.04)	345(1.28)	393(1.46)	1235(1)	1271(1.02)	1147(0.92)	1130(0.91)
IR-64	301(1)	316(1.04)	339(1.12)	389(1.29)	1550(1)	1333(0.86)	1203(0.77)	1056(0.68)
LSD*P<0.05	52				134			
Variety	**Fv/Fm**				**Y (II)**			
	Control	**100µM**	**200 µM**	**300 µM**	**Control**	**100µM**	**200 µM**	**300 µM**
Machhakanta	0.780(1)	0.787(1.0)	0.763(0.97)	0.679(0.87)	0.781(1)	0.787(1.0)	0.772(0.98)	0.717(0.91)
Haldichudi	0.795(1)	0.780(0.98)	0.719(0.90)	0.661(0.83)	0.777(1)	0.761(0.97)	0.731(0.94)	0.627(0.80)
Kalajeera	0.782(1)	0.778(0.99)	0.699(0.89)	0.652(0.83)	0.684(1)	0.673(0.98)	0.640(0.93)	0.643(0.94)
IR-64	0.805(1)	0.762(0.94)	0.716(0.88)	0.631(0.78)	0.792(1)	0.717(0.90)	0.659(0.82)	0.604(0.76)
LSD*P<0.05	0.036				0.045			
Variety	**qP**				**NPQ**			
	Control	**100µM**	**200 µM**	**300 µM**	**Control**	**100µM**	**200 µM**	**300 µM**
Machhakanta	0.663(1)	0.661(0.99)	0.613(0.92)	0.521(0.78)	0.415(1)	0.156(0.37)	0.295(0.71)	0.442(1.06)
Haldichudi	0.798(1)	0.784(0.98)	0.733(0.91)	0.662(0.82)	0.595(1)	0.590(0.99)	0.915(1.53)	0.965(1.62)
Kalajeera	0.894(1)	0.849(0.94)	0.715(0.79)	0.692(0.77)	0.440(1)	0.112(0.26)	0.290(0.65)	0.317(0.72)
IR-64	0.941(1)	0.740(0.78)	0.619(0.65)	0.581(0.61)	0.405(1)	0.145(0.35)	0.205(0.50)	0.454(1.12)
LSD*P<0.05	0.061				0.102			

Abbreviations in tables representing: Fo (minimal fluorescence at dark-adapted leaf), Fm (maximal fluorescence at dark-adapted leaf), Fv/Fm (Maximum quantum efficiency of PSII photochemistry), Y(II) (effective quantum yield of PSII photochemistry), qP (photochemical quenching), NPQ (non-photochemical quenching)

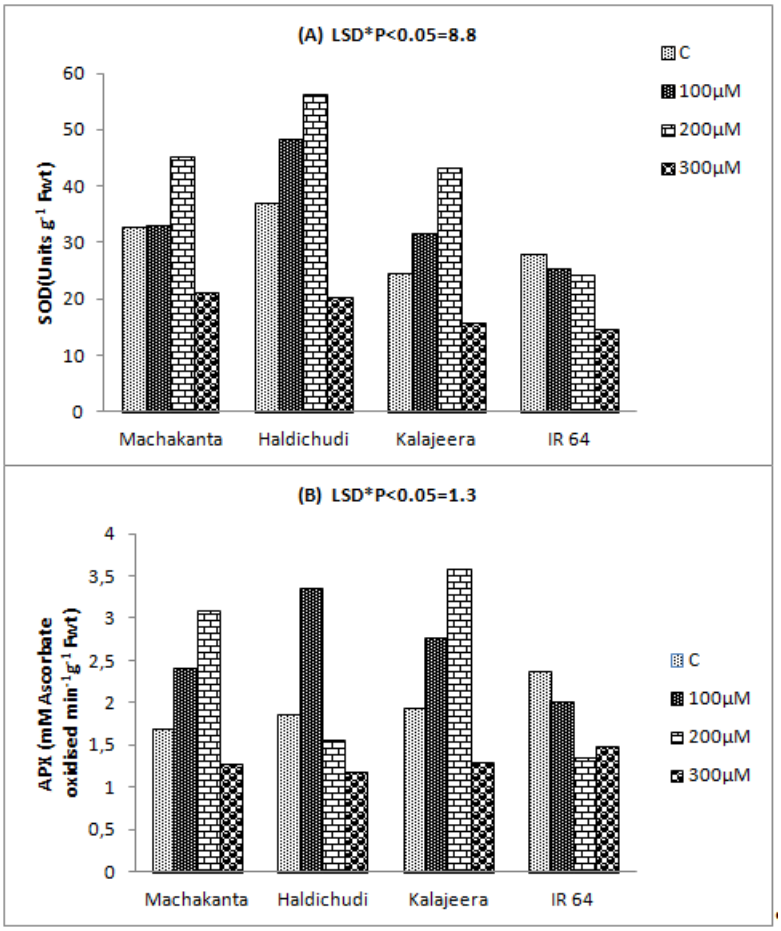

Figure 1: Changes of superoxide dismutase (SOD) and ascorbate peroxidase (APX) activity in different rice seedlings exposed to different concentrations of Al^{3+}.

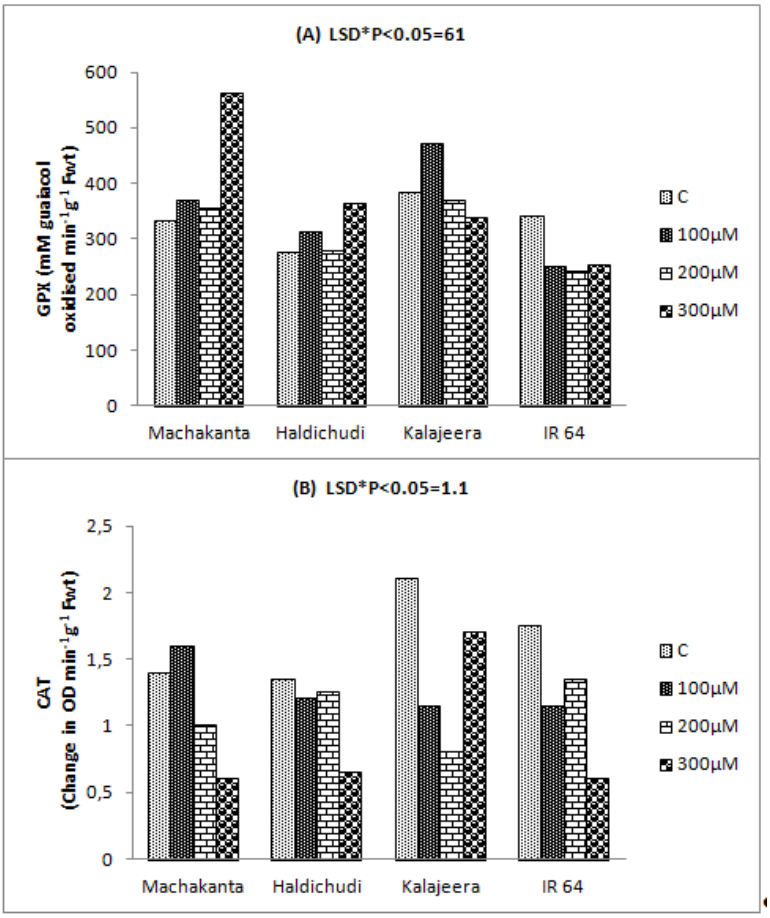

Figure 2: Changes of guaiacol peroxidase (GPX) and catalase activity (CAT) in different rice seedlings exposed to different concentration Al^{3+}.

CONCLUSION

In conclusion, higher concentration of Al^{3+}, inhibit the plant growth and alter PSII activity, as noticed from declining the values of Fm, Fv/Fm, Y (II), qP and increase of Fo and NPQ. The induction of activities of antioxidant enzymes such as SOD, APX and GPX in rice seedlings under elevated Al^{3+} concentrations shows its Al^{3+} tolerance potential. Based on the results, indigenous hill rice genotypes such as *Kalajeera, Machakanta* and *Haladichudi* exhibited superior photochemical activity and antioxidant defense than that of IR 64 cultivar. These landraces are highly tolerant and showed the adaptive fitness to Al^{3+} stress. Further research on genetic diversity in relation to Al^{3+} stress is required to use of these landraces for future Al^{3+} tolerance rice breeding program.

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CONFLICTS OF INTEREST

All authors have declared that they do not have any conflict of interest for publishing this research.

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