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Submergence tolerance in rice genotypes with reference to Peroxidase activity

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Abstract
This study was conducted to evaluate the submergence tolerance, response of peroxidase activity among 14 rice genotypes. Rice genotypes viz., Bad Dhana, Khawjii, Sambha, Lalkadhan, NDR9532, IR-72, Katy, NDR8610-2, Khaiyan, NDR9448, IR73707-43-3-23, NDR9930108, NDR9511, and Swarna sub-1 were evaluated for their peroxidase activity on fifteen days of submergence. Peroxidase activity was also recorded in normal as well as in submergence stress condition and maximum peroxidase activity under normal condition was noted in Bad Dhana and the minimum was noted in Sambha at all the stages of observation whereas, under stress condition maximum peroxidase activity was shown by Bad Dhana at 3rd day and minimum peroxidase activity was noted in Sambha at 1st day at all the stages of observation. In short peroxidase activities increased upto 3rd day their after declined trend were obtained. The results indicated that the submergence tolerance genotypes have higher peroxidase activity.

Keywords: peroxidase, submergence, tolerance, rice, genotypes

Introduction
Waterlogging is a serious problem that affects crop gas exchange in low-lying rain-fed areas. Approximately 30 % of the world's rice (*Oryza sativa*) farmlands are at a low elevation and irrigated by rain (Bailey-Serres *et al*. 2010) [3]. Under limited oxygen availability, photosynthesis and respiration are restricted, leading to an energy crisis, toxic products from anaerobic respiration and the accumulation of reactive oxygen species (ROS) in plant cells (Licausi and Perata 2009; Pucciariello *et al*. 2012a; Yang and Hong 2015) [10, 20]. Several studies have focused on the important role of ROS during hypoxia signaling under full submergence conditions (Baxter *et al*. 2014; Fukao *et al*. 2011; Liu *et al*. 2015; Yang and Hong 2015) [4, 8, 9, 20]. Plants have evolved defense mechanisms naturally to scavenge AOS by enzymatic and non-enzymatic antioxidant mechanisms. Several antioxidant enzymes have been evolved in detoxifying AOS. Among them, superoxide dismustase (SOD) is a major scavenger of O_2, which dismutises O_2 into H_2O_2 (Bowler *et al*. 1992) [5]. H_2O_2 is scavenged by ascorbate peroxidase (APX), glutathione reductase (GR), catalase (CAT), and some peroxidases (POX) (Asada 1997) [2].

'Escape' or 'quiescence' are two major types of adaptive response to submergence, seen in a wide range of species and based on the vigor of upward shoot elongation initiated by submergence (Ram *et al*. 2002) [15]. In most rice lines, the escape strategy takes the form of accelerated underwater elongation and is most marked in deep water lowland rice where vigorous stem extension prevents total submergence as floodwater gradually rises. However, leaves, stems and coleoptiles of almost all rice types elongate faster in response to submergence provided some oxygen is present. When fast shoot extension is insufficient to allow the plant to re-surface, the expenditure in energy and respirable substrates needed to support the faster underwater growth may threaten survival. The rice line 'FR13A' is an exception to this general rule. In contrast to most other rice lines 'FR13A' does not elongate faster underwater and thus conserves accumulated respirable biomass thereby adopting the so-called quiescence strategy (Singh *et al*. 2014) [18].

Continuous anaerobic metabolism can result in the accumulation of phytotoxic end-products. When floodwaters subside, submerged plants encounter the rapid entry of oxygen, causing oxidative damage through overproduction of reactive oxygen species (ROS) and toxic oxidative products (Crawford, 1992 and Fukao *et al*. 2011) [6, 8, 9].

Materials and methods

The experiment was conducted in earthen pots and submerged into cemented pond at the experimental site of the Department of Crop Physiology N.D.U.A.&T., Kumarganj, Faizabad (U.P.). Bold and healthy seeds of 14 rice genotypes (Bad Dhana, Khawjii, Sambha, Lalkadhan, NDR9532, IR-72, Katy, NDR8610-2, Khaiyan, NDR9448, IR73707-43-3-23, NDR9930108, NDR9511, and Swarna sub-1) were sown in the pot. Submergence was given to 35 days old seedlings at vegetative stage in pot culture for 15 days. At the time of submergence, water level was maintained at 30cm. The leaves were submerged in pond water. The level of pond water was maintained through water pipe. Control was kept without any submergence. Peroxidase activity was recorded at Control and (1^{st} day to 4^{th} day) after 20 days of de-submergence.

Peroxidase activity

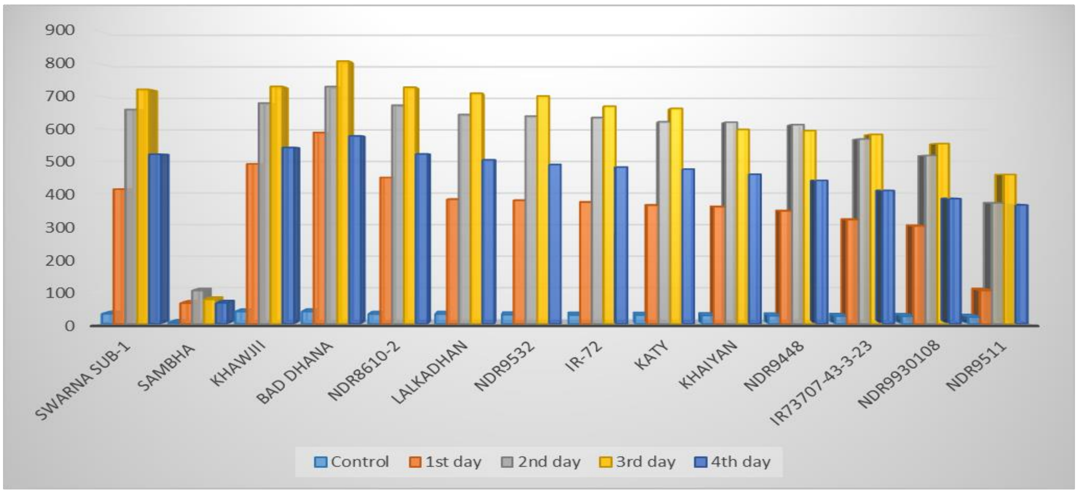
The activity of peroxidase was determined by the method at Curne and Galston (1959) [7].

Reagents: (i) Phosphate buffer 0.1 M (pH 6.0), (ii) Pyrogallol (0.1 N) (iii) H 2 O 2 (0.02 %)

Procedure:
200 mg fresh leaf material was homogenized in 10 ml of 0.1 M phosphate buffer (pH 6.0) and centrifuged at 10,000 rpm for 30 minutes at low temperature. 2 ml enzyme extract was taken in a test tube to which 2 ml phosphate buffer (pH 6.0), 1.0 ml Pyrogallol and 0.2 ml H 2 O 2 was added. The intensity of colour was measured at 430 nm on spectronic 20. Express result as enzyme unit g -1 fresh weight.

Result and Discussion

Peroxidase activity was also recorded in normal as well as in submergence stress condition and presented in graph and maximum peroxidase activity under normal condition was noted in Bad Dhana (37.88) followed by Khawjii (37.63) and the minimum was noted in Sambha (4.00) at all the stages of observation whereas, under stress condition maximum peroxidase activity was shown by Bad Dhana (806.83). followed by Khawjii (728.83) at 3^{rd} day and minimum peroxidase activity was noted in Sambha (3.42) 1^{st} day at all the stages of observation. Ushimaru *et al*. (1992) [19] reported that the increased activity of these enzymes under submergence might be due to possible absorption of molecular oxygen from the surrounding water. The combined action of enzymes is important for detoxifying toxicity. SOD merely acts on the superoxide anion, converting it to another reactive intermediate (H2O2), and CAT acts on H2O2, converting it to water and oxygen (Mates 2000) [13]. Flood-tolerant genotypes under submergence can thrive by effective energy maintenance through lower leaf expansion, minimum elongation, less chlorosis (Setter and Laureles 1996), high DMP, high carbohydrate reserve, and a strong antioxidant enzyme system (Sarkar *et al*. 2001) [17]. Similarly, A. Anandana and P. Arunachalamb (2012) [1] reported that the activities of all antioxidant enzymes were significantly greater in tolerant/avoidance genotypes than in the susceptible (C10) genotypes under both submergence and desubmergence. Seedlings of tolerant genotypes had higher survival, and the roots were more viable with greater capacity to elongate. Moreover, they had higher peroxidase activity and lesser increases in both electrolyte leakage and malondialdehyde production during submergence. There were strong positive correlations between survival and some parameters measured during submergence such as root elongation (r = 0.74**) and peroxidase activity (r = 0.79**, at day 7 of submergence) (Ella *et al*. 2015).



Conclusion

Findings of this study indicate that the peroxidase activity was higher in submergence tolerant genotypes and lower in susceptible genotypes in all days (1^{st} to 4^{th} day) but at 3^{rd} day after desubmergence highest activity was found in all tolerant genotypes. Submergence treatment has enhanced the level of Peroxidase activity. This indicated that the Peroxidase activity could be utilized as the selection criteria for evaluating submergence tolerance in rice.

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