Effect of seedling age and submergence on nitrate reductase and ~ amylase activity in rice

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ABSTRACT

A study was undertaken to study the response of submergence duration and age of the seedlings on enzyme activity like nitrate reductase and α-amylase. Leaf nitrate reductase activity of submergence tolerant rice genotypes like FR-13 A and TCA-85 was significantly higher than that of susceptible Pankaj and Mahsuri. Nitrate reductase activity declined under submergence in both tolerant and susceptible genotypes. A positive correlation was found between the nitrate reductase activity and survival (r^2=0.74), which may be utilized as criteria of selecting the submergence tolerant genotypes for improving rainfed lowland rice growing ecosystem. Varieties with higher reductase activity had higher survival rate under submergence while α-amylase activity decreased under submergence. Maximum reduction in α-amylase activity was recorded in treatment with 11 days submergence.

Key words**:** *rice, submergence, nitrate reductase, α amylase activity*

The main reasons for low productivity of rice in rainfed lowland is the unfavorable and uncertain weather conditions with water depth ranging from 20 to 60 cm and sometime reaching around 1 m. The productivity of rainfed lowland rice is low with an average grain yield around 1.0 -1.5 t ha^{-1} which is higher than upland and deep water rice but much lower than that of irrigated ecosystem. Rice is cultivated predominantly on flooded and anaerobic soils (Swaminathan, M.S. 1993) and by no means impervious to damage from poor aeration (Setter *et.al*. 1987) and this is a serious practical problem in the rain fed lowlands of Asia (Ziegler and Puckridge, 1995). Rice has adopted to submergence pond environment either through submergence tolerance or elongation ability. Flooding of submergence is known to create hypoxia or anoxia in the plant system due to slower diffusion of gasses in water (Armstrong, W. 1979. Greenwayand Setter, 1994). Therefore, an attempt was made to find out the biochemical changes especially, nitrate reductase and α amylase in submergence tolerant and susceptible genotypes.

A pot experiment was conducted during wet season 2007 at Faizabad (UP). Soil was silt loam in texture consisting of 0.641%, Organic C and pH 7.4. The experiment was laid out in complete randomize block design with three replications and consisted of four submergence durations (*i.e.* control, 3, 7 and 11 days). Seedlings were subjected to submergence under two age groups, namely 30 days after sowing (DAS) and 45 DAS. The observations were recorded before and after submergence. Biochemical analysis of nitrate reductase was estimated by the method of Jaworski (1971) and α amylase activity by the method of Chance and Maehly (1955).

Older seedling (45 DAS) had higher survival percentage as compared to younger seedling (30 DAS) under each submergence duration. The submergence duration of 11 days caused severe reduction in survival percentage followed by 7 and 3 days of submergence, respectively. These finding are similar to those of Srivastava *et al.* (2007). The interaction effect between variety and submergence was found to be significant, in both the seedling age groups. The percent reduction in nitrate reductase (NR) activity due to increasing submergence duration was more in submergence tolerant rice genotypes viz., Pankaj and Mahsuri under both the seedling age groups. After 11days of submergence reduction in nitrate reductase activity in

Mahsuri was 60.9 and 56.6 in seedlings of 30 DAS and 45 DAS, respectively (Table -1 and Fig. 1). After 3, 7 and 11 days of submergence tolerant rice genotypes e.g. FR-13A and TCA-85 had minimum reduction in nitrate reductase activity as compared to susceptible genotypes in both the seedling age groups (Table -1). Mazaredo and Vergara (1982) found that NR activity of the plant was highest in the leaves and generally higher in the tolerant varieties. Reggiani *et.al.* (1985) suggested a dissimilar role of nitrate reduction in *Oryza* during anoxia. Perhaps the oxygen generated from reduction of nitrate to nitrite oxidized NADH to regenerate NAD^+ which is essential for the continuation of glucolysis. A positive correlation was observed between the nitrate reductase activity and survival (r^2 = 0.74). Varieties with higher enzyme activities had higher survival under submergence.

The α-amylase activity increased with the increase of seedling age to 45 DAS. The interaction effect between genotypes and submergence treatment

Table-1. Effect of seedling age and submergence on nitrate reductase activity in rice

Genotypes	Seedling age 30 DAS							
	Submergence duration (days)							
	Survival %				NR activity µ mol nitrate /g fresh wt.			
	0	3	7	11	0	3	7	11
FR-13A	100	97.6	84.6	75.3	36.4	35.7	26.6	24.3
TCA-85	100	98.3	76.6	61.6	39.3	36.4	32.6	28.4
Pankaj	100	93.6	54.6	33.3	28.8	21.6	16.5	13.8
Mahsuri	100	94.6	45.3	30.3	26.1	20.5	15.6	10.2
C.D. at 5 %	V= 1.36 S= 1.36 V x S= 2.72				V=1.05, S= 1.05, V x S = 2.10			

Genotypes	Seedling age 45 DAS							
	Submergence duration (days)							
	Survival %				NR activity µ mol nitrate /g fresh wt.			
	0	3	7	11	0	3	7	11
FR-13A	100	100	91.7	86.0	47.4	44.2	37.8	34.1
TCA-85	100	99.3	92.6	87.0	50.0	46.5	40.2	36.4
Pankaj	100	97.3	66.6	45.0	47.8	30.9	24.9	18.4
Mahsuri	100	96.3	56.3	42.3	50.1	31.6	27.5	21.7
C.D. at 5 %	V= 1.78 S= 1.78Vx S= 3.57				V=1.09, S= 1.09, V x S = 2.18			

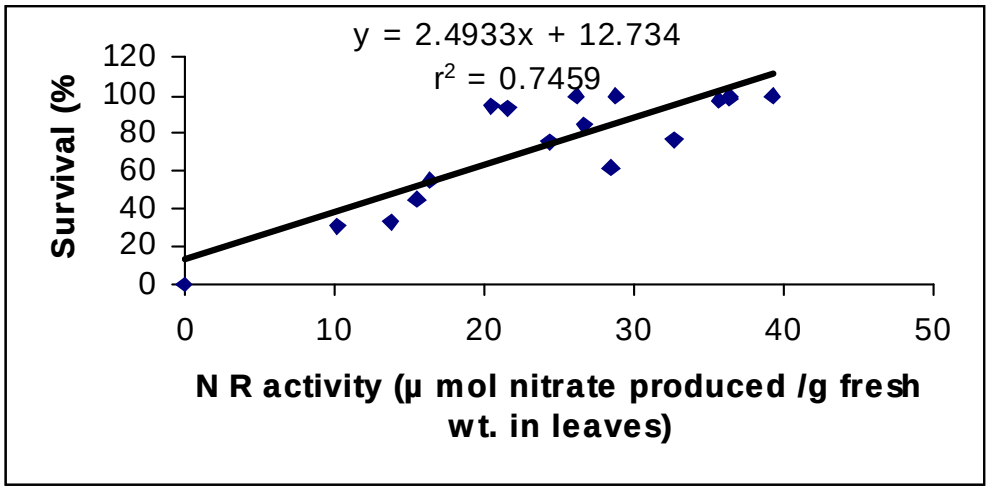

Fig.1 Association between percent survival and nitrate reductase activity in 30 days old rice seedlings

Table 2. Effect of seedling age and submergence durations on α-amylase activity in rice

Genotypes	Seedling age 30 DAS							
	Submergence duration (days)							
	30 DAS				45 DAS			
	0	3	7	11	0	3	7	11
FR-13A	176.6	96.6	69.9	55.8	285.0	155.0	125.0	94.0
TCA-85	170.4	86.6	60.5	52.8	285.6	150.0	127.6	86.3
Pankaj	181.9	110.2	85.6	74.1	285.0	187.3	168.0	118.0
Mahsuri	180.1	108.3	88.5	75.7	292.0	181.6	171.0	126.0
C.D. at 5 %	V= 2.15 S= 2.15 Vx S= 4.30				V=4.45, S= 4.45, Vx S = 8.91			

was found to be statically significant in both the seedling age groups. Susceptible rice genotypes Pankaj and Mahsuri had suggested that higher elongation during submergence needed more energy. Requirement of more energy was attributed to starch breakdown by α-amylase leading to increased α-amylase activity in susceptible genotypes (Table-2). Chaturvedi *et al*, (1995) advocated that α-amylase is one of the important enzymes which help in remobilization of sugar. Raskin *et al* (1984) had observed decreased α-amylase activity in rice leaves and internodes during submergence. With increasing duration of submergence the plant survival percentage decreased in all the four genotypes. Tolerant rice genotypes *viz*., FR-13A and TCA-85 had maintained higher survival percentage as compared to susceptible rice genotypes *viz*., Pankaj and Mahsuri.

Nitrate reductase activity and α-amylase activity decreased with increasing submergence duration. Maximum NR activity was noted in tolerant rice genotypes FR-13A and TCA-85 with increasing duration of submergence under both the seedling age groups. The deleterious effect of submergence was more pronounced under 11 days complete submergence than 3 and 7 days. This trait can be used for screening large number of genotypes for submergence tolerance.

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