ROOT GROWTH IN ADVERSE SOILS TOLERANT RICE VARIETIES

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ABSTRACT

Pot experiments were conducted at the Rice Research Station, Ambalantota, to find out the root growth and tolerance mechanism of the newly recommended saline resistant variety Pokkali. Results shows that the rooting depth and root weight of these two hybrids derived from a cross between Pokkali and Bg 94-1 is greater than Pokkali. However, at early stages of growth variety Pokkali had thick roots compared to all other tested varieties. The other tested varieties which also has tolerance to other adverse soil conditions also had comparative rooting depths and weights and was significantly different to susceptible check variety Bg 350. Thus the tolerance mechanism of these varieties for adverse soil conditions may probably be their extensive root systems but the osmotic adjustment which was not monitored cannot be ruled out.

INTRODUCTION

The threat of soil salinity looms large in the 230 million hectares of world irrigated area[1] that produces almost half of the world food[2]. About 27 million hectares in the humid tropics of Asia lies uncultivated because of salinity[3]. In Sri Lanka large area of rice lands especially in irrigated agriculture projects lies idle due to salinity.

Tolerance to adverse soil conditions in the rice plant could be either due to osmotic adjustment by the plant cells to

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maintain an absorption gradient towards the cell or by having extensive root system to maintain a large absorbing area or combination of both. Rice root system is fibrous in nature, which originate from stem nodes and maintain a definite relationship with emergence and development of the leaves.[4] Thus the number and weight of roots increases with age and attain their maximum values at the time of heading. Recently developed rice varieties having better tolerance and high yielding capacity, recommended by the Department of Agriculture to replace long standing variety Pokkali, could have build up resistance through any or combination of the above factors.

This study was therefore reports on root studies conducted to find out the tolerance mechanism of these resistant varieties.

MATERIALS AND METHODS

An observation study was conducted at Rice Research Station, Ambalantota, during 1992 Yala season using 6 rice varieties: Pokkali (salinity tolerant), Nonabokra (alkalinity tolerant), Moroberekkan (Drought tolerant), AT 354 (salinity tolerant), At 401 (salinity tolerant) and Bg 350, in pots containing moist equivalent of 10 kg of oven dry lowland saline rice soils. Salinity index of soil in this experiment was maintained between 4 -5 mS/cm throughout the study by adding common salt whenever necessary.

Based on the results of this experiment a replicated experiment was conducted in Maha 1992/93 using same 6 rice varieties. Variety Pokkali is used as the resistant check and Bg 350 as the susceptible check. Three replicates were used. Each pot with 0.3 cm^3 volume containing the same weight as above, of saline rice soil having salinity index of 5.2 mS/cm. The pot was divided into three compartments using polythene strips after the basal fertilizer application and 1-day-old single plants were transplanted at each compartment.

Plant sampling was carried out at monthly intervals and at harvest. Salinity level of the soil was maintained between 5-6 mS/cm in saturation extract by adding common salt when necessary. Fertilizer N P_2O_5, K_2O at the rate of 100:25:20 kg/ha was applied, all P and K and 30N was applied basally and the rest 70 N applied 8 weeks after transplanting. At each sampling, soil core with the plant was removed and washed off the soil

and the wet weight of roots was recorded. These roots were then placed in an oven maintained at 80°C and dried to a constant weight and recorded.

RESULTS

Results obtained in the observation study is presented in Table 1 and that of replicated trial in Table 2. Results of observation study clearly showed that varietal differences exists, with the highest root length and weight observed in the variety Moroberekkan and the lowest in Bg 350 which was the susceptible check.

Table 2 shows significant differences in root length and root dry and wet weights of different varieties after 2 months of age. Results shows that the root weight of Bg 350 was significantly lower at 2 months after sowing (2 MAS) while at harvest it was significantly lower than varieties At 354 and At 401. At 401 gave the highest root wet weight 2 MAS and At 354 at harvest. Root dry weight followed the same trend as root wet weight. The standard variety Pokkali gave root lengths significantly lower than At 401 at harvest and lower values at 1 MAS and 2 MAS compared to At varieties. Root wet and dry weights of the variety Pokkali was highest at 1 MAS was significantly lower to At varieties at 2 MAS and comparable to AT varieties at harvest.

DISCUSSION

Primary function of the root system in plants is the absorption of water and nutrients necessary for normal plant growth. Salinity which is an abiotic stress causes physiological moisture stress which hamper normal water and nutrient absorption.

Tolerance to abiotic stresses such as salinity in plants is either through osmotic adjustment by root cells or by having greater surface area for absorptive purposes through deep seating and/or greater volume. Root weight one month after is higher in variety pokkali though not significant, indicated that thicker roots develop in this variety at the beginning which increase the seedling tolerance to salinity of this variety.

Variety Moroberekkan is a variety having moderate tolerance to drought, under lowland conditions it gave the highest values of the three parameters measured. The other varieties gave moderate values for the parameters measure as they are also having tolerance to physiological drought caused by

soil problems. These results thus clearly indicated that the rice varieties resistant to abiotic stresses such as salinity, alkalinity and drought has larger root volume and deep seated root systems.

Root length data of the replicated experiment showed that the standard variety Pokkali had lower rooting depths than other varieties except the control, but the differences were significant at harvest time only. Mori (1958) indicated that root mass and length are greatest at heading and roots that develop after panicle initiation (PI) elongate and branch until maturity in normal soils. The two varieties that showed the highest root length are hybrids derived from a cross between Pokkali and a high yielding new improved variety Bg 94-1.

Highest root length of the variety AT 401 shows that the root length and volume of rice is a quantitative character determined by several genes having additive effects. Since variety Bg 94-1 is susceptible to salinity, the donor gene would have come from the standard variety pokkali and hybridization to Bg 94-1 improved the tolerance level of these two varieties through increased root length and volume. Since At 354 and At 401 have deep seated root systems and At 401 is significantly different to its parent Pokkali, and no difference between At 354 and At 401 at harvest proves that these two varieties have better tolerance than the parent variety, (Ikehashi and Ponnamperuma 1978) would have occurred thus increasing their tolerance to salinity.

Root dry weight and wet weight took similar trends where the highest root weights were recorded by the Variety At 401 at 2 MAS and was not significantly different to all other tested varieties having tolerance to abiotic stresses except the susceptible check variety Bg 350 at harvest. Further the highest root weight at 1 MAS was observed in the variety pokkali and the fact that it has the shortest rooting depth indicates that this variety has a thick rooting system at early seedling stage which could probably be the mechanism of tolerance of this variety at early stages of growth. However at later stages the hybrids of pokkali are having greater root weights than the pokkali suggesting the gene recombinations having additive quantitative effects would have gain entry to the gene pool of these varieties due to hybridization.

However in these experiments data on osmotic adjustments which is another mechanism of tolerance to abiotic stresses of different varieties was not studied due to lack of facilities and therefore this mechanism of tolerance of the tested varieties cannot be ruled out. Hence the mechanism of tolerance of these rice varieties can be the development of extensive root systems with or without osmotic adjustments.

Table 1: Root length, Root wet and dry weights of different rice varieties, observational study, Pot experiment, Yala 1992

Variety	Root Length (cm)			Root wet weight (g)			Root Dry weight (g)		
	1MAS[a]	2MAS[b]	H[c]	1MAS	2MAS	H	1MAS	2 MAS	H
Pokkali	20	31	35	9.8	39.0	31.8	1.5	6.2	6.1
Monabokra	18	29	45	8.3	41.0	29.8	1.9	6.8	5.4
Moroberekan	15	33	46	6.2	30.0	36.3	0.8	5.2	6.6
Bg 380	22	26	30	2.5	21.5	9.4	0.2	2.2	1.5
At 354	18	30	35	9.7	34.0	37.8	1.8	6.2	7.5
At 402	19	31	45	7.6	41.5	37.2	1.3	7.4	5.9

Table 2: Root length, Root wet and dry weights of different rice varieties, Pot experiment, Maha 1992/93

Variety	Root Length (cm)			Root wet weight (g)			Root Dry weight (g)		
	1MAS[a]	2MAS[b]	H[c]	1MAS	2MAS	H	1MAS	2 MAS	H
Pokkali	22.0[ns]	28.0[ns]	28.7[a]	0.83[ns]	0.64[b]	0.97[abc]	0.19[ns]	0.10[b]	0.16[ab]
Monabokra	22.0	28.3	26.7[a]	0.40	0.96[bc]	0.83[abc]	0.07	0.15[bc]	0.11[ab]
Moroberekan	22.7	27.0	30.7[ab]	0.62	1.15[c]	0.81[ab]	0.11	0.17[c]	0.12[ab]
Bg 380	21.0	22.5	28.0[a]	0.39	0.17[a]	0.63[a]	0.06	0.02[a]	0.08[a]
At 354	23.0	32.3	33.3[ab]	0.45	0.93[bc]	1.27[c]	0.06	0.13[bc]	0.20[b]
At 402	23.3	37.0	40.0[b]	0.63	1.82[d]	1.23[bc]	0.06	0.29[d]	0.14[b]
CV%			17.3		20.4	23.7		25.7	30.4

a - Month after sowing
b - 2 Months after sowing
c - Harvest
ns - Non significant

In a column means denoted by a common letter is not significantly different at 1% level of probability.

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