Evaluation of Level of Drought Tolerance in Traditional Rice Cultivars in Sri Lanka at the Seedling Stage

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Abstract

Rice consumes more water than any other commercially valuable crop. In the phase of increasing water shortage, introduction of rice cultivars with less water consumption is needed. Sri Lankan traditional rice cultivars were evaluated for drought stress tolerance at the seedling stage to find out comparatively better drought resistant varieties within the gene pool. Forty three traditional rice cultivars collected from the Plant Genetic Resource Centre, Gannoruwa, Sri Lanka and known drought tolerant modern rice variety Bg 352 were used for the study. The experiment was conducted at Faculty of Agriculture, Mapalana. Dormancy broken seeds were allowed to germinate at 35 °C and the germinated seeds were planted in plastic boxes (15 cm X 7.5 cm X 15 cm) filled with homogenized soil up to ¾ of the total depth according to completely randomized block design with 20 plants per replicate. Four weeks after planting water supply was restricted. Five days after 80% of the plants were completely withered plants were re-watered once for recovery. Plant survival percentage was recorded 10 days after re-watering. After data recording, plants were under gone a second cycle of drought stress. Plants were re-watered five days after 80% of the rest of the plants were completely withered. Ten days after re-watering plants were evaluated by measuring green plant length, root length and dry matter weight of the recovered plants. According to the results significantly highest ($p<0.05$) survival percentages were observed in Mas samba, Kottamalli, Bathkiri el, Kollikuttu, Kahata samba, and Rankirial cultivars. Significantly highest root lengths were recorded in Yakada wee, Dewaradderi, Masuran, Moddai karuppan, Rathu heenati and Rathel over other accessions, while significantly highest shoot lengths were recorded in Seedevi, Kolikuttu, Sivuru wee, Rathel, Dewaradderi and Masuran. The significantly highest ($p<0.05$) dry shoot weight was recorded in Kollikuttu, Seedevi and Dewaredderi accessions. The significantly highest dry root weight was recorded in Kollikuttu, Kahata samba and dewaredderi accessions. These cultivars must be further studied under drought stress at other growth stages.

Introduction

Rice varieties differ greatly in their ability to tolerate moisture deficit. As example, notable levels of drought tolerance have been observed in rice cultivars Azucena from the Phillipine and in Moroberekan from Guinea. Drought resistance in rice depends on one or more factors such as ability of roots to exploit deep soil water, the capacity for osmotic adjustment and the ability to control and reduce water loss (Nguyen et al. 2004). Low root activity under the dry condition adversely affects on rice growth and yield. Root growth affects on shoot growth either physiologically or through nutrient and water absorption and translocation (Mambani and Lal 1983).

Development of drought tolerant rice varieties become one of the major objectives in Rice Research Development Centers, as drought has become the important limiting factor for rice production. Therefore, development of high yielding and drought tolerant rice cultivars by exploiting the rich genetic diversity in the primary gene pool of rice is prime important. Molecular approaches to develop drought tolerant rice cultivar have been applied by QTL analysis. Identification of traditional rice cultivars with strong drought tolerance will be a valuable source for such studies. Sri Lanka traditional rice gene pool is very rich in abiotic stress tolerant genes. For example in a recent study of 76 rice cultivars, nine Sri Lankan indigenous cultivars were among the top thirteen for survival under submergence for 2 weeks . Hence, screening of available traditional rice germplasm against abiotic stress tolerances including drought is important for exploiting new materials for future rice development programs. Screening methodology for the drought tolerance in rice at seedling stage has been developed (Ranawake et al. 2010a). In the present study 43 traditional rice cultivars were evaluated for level of drought tolerance at the seedling stage.

Materials and Methods

Forty three traditional rice cultivars were collected from Plant Genetic Resource Centre, Gannoruwa, Peradeniya, and modern rice variety Bg 352 was collected from Rice Research and Development Institute, Bathalagoda. Dormancy broken seeds were allowed to germinate at 35 0C and the germinated seeds were planted in plastic boxes (15 cm X 7.5 cm X 15 cm) filled with homogenized soil up to ¾ of the total depth according to completely randomized block design with 20 plants per replicate. Water supply was restricted at four weeks after planting. Five days after 80% of the plants were completely withered plants were re-watered for recovery. Plant survival percentage was recorded 10 days after watering. The second cycle of drought stress (Second dehydration treatment) was applied after data recording on plant survival percentage. Plants were re-watered five days after 80% of the rest of the plants were completely withered. Ten days after re-watering plants were evaluated by measuring green plant length, root length and dry matter weight of the recovered plants.

Results and Discussion

Among tested rice cultivars the significantly highest ($p<0.05$) survival percentage was observed in Mas samba, Kottamalli, Bathkiri el, Kolikuttu, Kahata samba, Rankirial and Bg 352 cultivars after 2nd

Table 1: Traditional rice accessions used for the study

No	Accession No	Accession name	No	Accession No	Accession name
1	2196	Rathel	23	3543	Gonabaru
2	2202	Suduru samba	24	3550	Bathkiri el
3	2203	Dik wee I	25	3592	Ranhiriyal
4	2340	Weda Heenati	26	3605	Seedevi
5	2349	Mas samba	27	3629	Ruwanrathran
6	3071	Polayal	28	3644	Herath
7	3132	Heenati 309	29	3663	Murunga
8	3142	Molaga samba G - 18	30	3672	Mudaliwi
9	3146	Dewaredderi 26081	31	3676	Denawee
10	3160	Valihandiran	32	3684	Rathkara
11	3162	Kiri naran	33	3692	Handiran
12	3171	Sudu hetada	34	3695	Kahata samba
13	3204	Kalukantha	35	3707	Heenati
14	3214	Matholuwa	36	3713	Kalukanda
15	3282	Ahamba	37	3721	Manamalaya
16	3387	Kahata wee	38	3725	Sivuru wee
17	3388	Moddaikaruppan	39	3737	Kottamalli
18	3390	Rathu heenati	40	3833	Kolikuttu
19	3444	Dik wee II	41	3857	Sudu wee
20	3445	Yakadawee	42	3882	Dostara heenati
21	3472	Masuran	43	3573	Pokkali
22	3473	Rathu wee	44		Bg 352

dehydration treatment. Among tested 43 rice cultivars 63% cultivars showed survival under drought stress. Mas samba, Kottamalli, Bathkiri el, Kollikuttu, Kahata samba, Rankirial and Bg 352 showed significantly highest ($p<0.05$) drought tolerance over the other cultivars at both 1st and 2nd drought treatments

The significantly highest ($p<0.05$) root length was recorded in Yakada wee, Dewaradderi, Masuran, Moddai karuppan, Rathu heenati and Rathel over other accessions. There was a positive correlation ($r=0.326$) between root length and plant survival percentage according to Pearson correlation coefficient ($\alpha = 5\%$). In addition, significantly highest shoot lengths were recorded in Seedevi, Kolikuttu, Sivuru wee, Rathel, Dewaraddiri and Masuran indicating their drought tolerance at the seedling stage.

The significantly highest ($p<0.05$) dry shoot weight was recorded in Bg 352. In addition, the highest dry shoot weights were recorded in Kollikuttu, Seedevi and Dewaredderi accessions. However, the significantly highest dry root weight was recorded in Kollikuttu, Kahata samba and Dewareddiri accessions. There was a positive correlation ($r=0.502$) in between total dry matter weight and plant survival percentage according to Pearson correlation analysis ($p<0.05$).

Some of these rice cultivars were evaluated for submergence tolerance at the seedling stage (Ranawake et al. 2010b). Interestingly, among cultivars evaluated for both drought and submergence tolerance Mas Samba and Rathuheeneti were tolerance for both drought and submergence stresses. Rice cultivars Yakada wee, Dewareddiri and Masuran which were drought tolerance were submergence tolerance under 9 day complete submergence stress as well.

Traditional rice cultivars Kollikuttu, Kahata samba, Masuran, Dewaradderi showed significantly highest values for each drought tolerant parameters measured at the experiment such as high survival percentage, higher green shoot length, greater root lengths and dry matter weight under drought stress. These rice cultivars must be further studied for future implementation in drought tolerant rice cultivars

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