CONCLUSIONS

There was a remarkable variation in expression of leaf and fruit traits in 50 pumpkin accessions such as leaf size, fruit shape, and fruit flesh quality. The range of first flowering was 82 - 121 days and the early flowering was observed in Phac deng cham variety (T11497). Co nhum variety (T11505) produced the maximum number of 16 fruits/plot and with highest yield of 12.76 tons/ha. 32 pumpkin accessions had sweet flesh flavor.

ACKNOWLEDGEMENT

The author would like to thank Dr. Tran Thi Thu Hoai and Mrs. Nguyen Thi Tam Phuc from the Plant Resources Center for their help during the experimental implementation.

REFERENCES

Ahamed KU, B Akhter, MR Islam, N Ara and MR Humauan, 2011. An assessment of morphology and yield characteristics of pumpkin *(Cucurbita moschata)* genotypes in Northern Bangladesh. *Tropical Agricultural Research & Extension* 14(1): 7-11.

Gerardus J. H. Grubben, 2004. Vegetables (Prota 2). *Plant Resources of Tropical Africa*, pp. 263-278.

Grubben GJH and Ngwerume FC, 2004. *Cucurbita moschata* Duchesne In: Grubben, G.J.H. & Denton, O.A. (Editors). PROTA 2: Vegetables/Légumes. [CD-Rom]. PROTA,Wageningen, Netherlands.

International Union for the Protection of new varieties of plants (UPOV), 2007. Pumpkin (*Cucurbita*). *Guidelines for the conduct of tests for distinctness, uniformity and stability*. Geneva, 2007.

Le Tuan Phong, Le Kha Tuong, 2011. Pumpkin production, potential and challenge. *Journal of Vietnam Agricultural Science and Technology*, No.2/2011. Pp: 46-50 (in Vietnamese).

Nguyen Thi Tam Phuc, 2014. *Evaluation of pumpkin germplasms.* MSc Thesis on Agricultural Sciences. Hanoi Agricultural University (in Vietnamese).

Date received: 19/11/2018
Date reviewed: 3/12/2018
Reviewer: Dr. Dao Thi Oanh Yen
Date approved for publication: 21/12/2018

EVALUATING SALT TOLERANCE OF SOME ELITE RICE VARIETES IN THE COASTAL REGIONS OF NAM DINH PROVINCE

Nguyen Xuan Dung*[1], Nguyen Thanh Phuong[1], Le Quoc Thanh[2]

Abstract

Climate change causes serious impacts on agricultural production, especially on rice production in Vietnam. Sea level rise threads to reduce rice productivity and farmer living in Red River Delta and Mekong River Delta due to salt water intrusion which salinizes water irrigation and soil cultivation. To response effectively to negative impacts of climate change, this study was conducted to evaluate the salt tolerant capacity of promising rice varieties which are able to adapt to conditions in coastal regions in Nam Dinh province of the Red River Delta in Vietnam. Two potential rice varieties named TX111 and M15, which not only had high yield, good quality (yields of TX111 and M15 in spring were 8.02 tons/ha and 7.41 tons/ha, respectively; in summer, yield of TX111 was 5.91 tons/ha, and yield of M15 was 4.42 tons/ha), but also high tolerance to salinity levels in the conditions of Red River Delta were selected.

Keywords: Red River Delta, rice, salt tolerance

INTRODUCTION

Vietnam has long coastline with 3,260 km and varied geography, so it is considered as one of the countries to be severely vulnerable to climate change (Dasgupta *et al.,* 2007; Dasgupta *et al.,* 2010). One of the major risks of climate change to Vietnam is sea level rise. If the sea level rises by one meter, about 39% of the Mekong River Delta area and over 10% of the Red River Delta are flooded, which will lead to the significantly impacts on food production and life of Vietnamese citizens (MONRE, 2012). When sea level rises by 1 m, land with the area of 4 million ha may be flooded annually in Vietnam (Zeidler, 1997). Sea level rise also increases the level of salinization of land and water, which seriously affect crop production, especially rice production (Hanh *et al*., 2007). The Vietnam Institute of Water Resources Planning reported recently that 4‰ salinity level in water will occur 40 km inland,

[1] Center for Technology Development and Agricultural Extension; [2] Vietnam Academy of Agricultural Sciences
* Corresponding author: Nguyen Xuan Dung. Email: dung.ricevietnam@gmail.com

far from sea borders, and affect at least 300,000 ha of rice (*Oryza sativa* L.) that currently produces the highest yield. In addition, about 10% of population will be affected and 10% of GDP will be lost (Vien, 2011). Therefore, the development of suitable solutions to adapt climate change is extremely important to Vietnam, particularly in coastal regions.

Nam Dinh province is one of the key agricultural regions in the Red River Delta of North Vietnam, and main agricultural products are rice, corn, soybeans, etc. Rice is the major crop in Nam Dinh province, cultivated on over 80,000 hectares. However, about 12,000 hectares in coastal districts of this province are affected by salinity. In the context of climate change, the province tends to adopt potential rice varieties which have good salt tolerance to develop in coastal districts of the province in order to ensure food security in these areas as well as in the province. Thus, this experiment was implemented in order to evaluate the salt tolerance of five potential rice varieties under irrigation of salt water in two dominant coastal districts in Nam Dinh.

MATERIALS AND METHODS

Materials

The experiment was designed to evaluate performance of five rice varieties named TX111, LTh134, M14, M15 and BT7 under saline conditions on the fields in Nam Dinh.

Methods

The experiment was performed as a Randomized Complete Block Design (RCBD) with four replications of 5 rice cultivars. Each plot had the area of 10 m^2, with 0.3 m space interval. Rice varieties were sown on the early of February in Spring crop and at the end of June in summer season. Then all varieties were transplanted into experimental plots at the density of 40 - 45 plants/m^2 at 15 days after sowing.

Experiment was designed as the following layout (Table 1).

Table 1. Layout of the experiment

Protected line	Protected line						Protected line
	Rep. 1	BT7 (control)	TX111	M14	M15	LTH134	
	Rep. 2	TX111	M14	LTH134	BT7 (control)	M15	
	Rep. 3	M14	BT7 (control)	M15	LTH134	TX111	
	Rep. 4	M15	LTH134	BT7 (control)	TX111	M14	
	Protected line						

Fertilizer application: The rate of chemical fertilzers for one hectare was 110 kg N - 60 kg P_2O_5 - 80 kg K_2O in spring season and 100 kg N - 60 kg P_2O_5 - 80 kg K_2O in summer season. "Lam Thao" NPK fertilizer was applied before transplanting. Urea was applied at three development stages such as: 10 - 15 days after transplanting, tillering and panicle differentiation. Potassium chloride was applied two times: 10 - 15 days after transplanting and at the stage of panicle differentiation. The fertilizer applications were broadcasted by hand. Standard management was applied to control pest and diseases.

Observation data included salt level (weekly), plant height, number of panicle per plant, number of filled grain per panicle, and grain yield. All plots were harvested by hand. The grain was dried, cleaned and weighed.

Time and place of the study

The experiment was conducted in Spring and Summer seasons in 2014 on salinized fields of Thinh Long and Rang Dong districts.

RESULTS AND DISCUSSION

The salinity levels in the irrigation water at experimental locations in Nam Dinh in 2014 were presented in the Fig. 1.

Figure 1 showed that salt concentrations in irrigation water in both sites were from 2 to 3.5‰, and the salt levels in Rang Dong were higher than in Thinh Long in both growing seasons. The highest salt concentration in Rang Dong in the Spring season was at the time of before transplanting stage (3.2‰), while this value in Thinh Long was 7 days and 21 days after transplanting stages (2.8‰). At harvesting stage in spring season, the salinity levels in Rang Dong and Thinh Long was equal to 2.1‰. In Summer season, the salt concentration in Rang Dong was slightly higher than in Thinh Long at all observed periods.

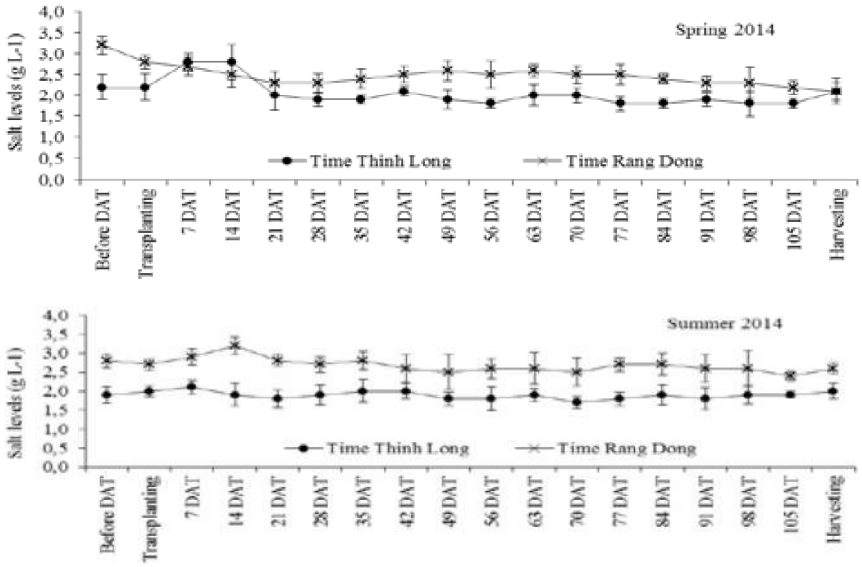

Figure 1. Salinity levels at experimental sites in Nam Dinh, 2014

Note: DAT: Days after transplanting.

Table 2. Evaluation of selected agronomic characteristics in Rang Dong and Thinh Long under saline water irrigation in 2014

Varieties	Growth duration (days)		Number of tillers per plant		Plant height (cm)	
	Rang Dong	***Thinh Long***	***Rang Dong***	***Thinh Long***	***Rang Dong***	***Thinh Long***
Spring						
TX111	135	134	8.6	8.9	110 ± 3.8	119 ± 2.4
M15	130	131	8.6	8.4	105 ± 2.5	114 ± 3.5
BT7 (Ctr)	130	130	8.2	8.6	100 ± 2.8	97 ± 1.7
M14	135	134	8.5	8.7	105 ± 1.8	110 ± 3.8
LTH134	127	125	7.4	7.9	87 ± 3.2	114 ± 2.5
CV (%)	*5.6*	*7.8*	*6.3*	*4.3*	*8.7*	*7.4*
$LSD_{0.05}$	*6.3*	*5.4*	*0.9*	*0.7*	*5.4*	*4.8*
Summer						
TX111	113	109	8.2	8.4	109 ± 3.0	108 ± 3.8
M15	115	106	7.9	7.8	105 ± 2.0	105 ± 2.5
BT7 (Ctr)	113	105	7.6	7.4	99 ± 1.9	97 ± 2.8
M14	115	106	7.7	7.4	103 ± 3.5	103 ± 1.8
LTH134	109	103	6.8	7.3	86 ± 1.4	93 ± 3.2
CV (%)	*7.8*	*6.7*	*5.8*	*8.6*	*7.5*	*7.3*
$LSD_{0.05}$	*4.3*	*3.4*	*1.1*	*0.9*	*7.7*	*5.9*

Note: Ctr: Control variety.

Results in table 2 showed that the influence of salinities on the number of tillers was not significant among tested varieties. The symptoms of salt effect such as white color on tip of affected leaves were observed on field studied markedly visible at two weeks after transplanting.

Duration of tested varieties in spring was significantly longer than in summer. Result in table 2 showed that duration of 5 rice varieties in Rang Dong was significantly longer than in Thinh Long in Summer because after transplanting 10 days, the lack of irrigation happened for a week, and as consequence,

the growth of seedlings, tillering and flowering occured earlier than in Rang Dong. In spring, TX111 had the longest growth duration in both Thinh Long and Rang Dong, while LTH134 had shortest growth duration at both studied sites. This variety had the growth duration of 109 days in Rang Dong in Summer, 6 days longer than in Thinh Long. In Spring season, LTH134 was the variety which had the lowest height in Rang Dong (87 cm), while it was BT7 in Thinh Long (95 cm). However, in summer season, the results at both sites indicated that LTH134 was the lowest plant height variety.

Yield and yield components:

Grain yield was significantly higher ($P < 0.05$) in spring than in summer at both Rang Dong and Thinh Long due to varieties and sites. For example, in spring season, in Thinh Long, the variety TX111 produced the highest yield (6.22 tons/ha) followed by M15 (5.67 tons/ha) two varieties LTH134 (5.83 tons/ha) and BT7 (5.56 tons/ha); the lowest rice yield (5.26 tons/ha) was obtained in M14. Meanwhile, in Rang Dong, the rice variety which had the highest yield was TX111 (8.02 tons/ha) and the control variety (BT7) had the lowest yield (7.00 tons/ha).

In summer season, in Thinh Long, the variety TX111 produced the highest yield (5.88 tons/ha) followed by M14, and BT7 (5.24 tons/ha), the lowest rice yield (4.01 tons/ha) was obtained in LTH34. Meanwhile, in Rang Dong, the rice variety which had the highest yield was TX111 (5.91 tons/ha) and the LTH34 had the lowest yield (3.97 tons/ha).

Table 3. Effects of salinity on yield components and grain yields in Rang Dong and Thinh Long during Spring and Summer 2014

Varieties	No. of panicle per m^2		No. of filled grains per panicle		1000 seeds weight (g)		Yield (tons ha^{-1})	
	Rang Dong	*Thinh Long*	*Rang Dong*	*Thinh Long*	*Rang Dong*	*Thinh Long*	*Rang Dong*	*Thinh Long*
Spring								
TX111	244	244	189	141	22.6	20.9	8.02[a]	6.22[a]
M15	232	232	175	120	22.3	22.0	7.41[b]	5.67[b]
BT7 (control)	223	224	165	121	20.4	19.0	6.60[c]	5.56[b]
M14	227	228	159	115	22.2	21.6	7.22[b]	5.26[c]
LTH131	220	220	173	126	19.8	18.5	7.00[b]	5.82[b]
CV (%)	*7.0*	*4.0*	*6.6*	*7.9*	*7.7*	*5.9*	*2.5*	*6.2*
$LSD_{0.05}$	*3.6*	*3.0*	*2.4*	*4.0*	*0.14*	*0.15*	*0.11*	*0.10*
Summer								
TX111	224	224	161	140	23.1	21.2	5.91[a]	5.88[a]
M15	216	216	132	122	23.4	22.3	4.42[b]	5.24[b]
BT7 (control)	211	212	140	123	20.0	18.9	4.56[b]	5.24[b]
M14	212	212	136	125	20.3	21.2	4.68[b]	5.24[b]
LTH131	200	200	127	118	22.7	18.8	3.97[c]	4.01[c]
CV (%)	*7.4*	*4.1*	*9.4*	*6.7*	*7.6*	*7.4*	*6.8*	*7.3*
$LSD_{0.05}$	*2.3*	*3.9*	*3.1*	*5.2*	*3.2*	*2.1*	*3.14*	*3.28*

Note: Means followed by the same letter in the same column do not differ at 0.05 level.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

TX111 and M15 showed the best potential varieties, these varieties had the highest yield in both tested seasons, for instance, yields of TX111 and M15 in spring were 8.02 tons/ha and 7.41 tons/ha, respectively; in summer, yield of TX111 was 5.91 tons/ha, and yield of M15 was 4.42 tons/ha. Thus, TX111 and M15 can be developed in the saline regions in Nam Dinh province.

Recommendations

- To develop rice production sustainably in salinity intrusion areas, farmers need to be supplied with good quality seed at a reasonable price.

- Breeding and seed production should be initiated in these areas with necessary effort and investments

should be made to enhance breeding for salt tolerant rice adapting on saltwater intrusion conditions. Farmers should be trained on appropriate soil and water management measures, testing salinity and using salt tolerant rice varieties.

Further experiments need to be implemented for more crop seasons to identify scientific results for encouragement of applying advanced technology such as new rice varieties and cultivation technique in similar ecological regions in the Red River Delta.

In addition, it is important to improve the irrigation infrastructure to increase the availability of fresh water for flushing out salts. Under low rainfall periods, fresh water use for irrigation is limited and hence, it is a constraint.

REFERENCES

Dasgupta S, Laplante B, Meisner C, Wheeler D, Yan J, 2007. *The Impact of Sea Level Rise on Developing Countries: A Comparative Analysis.* World Bank Policy Research Working Paper No. 4136.

Dasgupta S, Laplante B, Murray S, Wheeler D., 2010. Exposure of developing countries to sea-level rise and storm surges. *Climatic Change*. DOI 10.1007/s10584-010-9959-6.

MONRE, 2012. *Vietnam climate change and seas level rise.* Natural Resources and Environment publishing house. Ministry of Natural Resources and Environment.

Hanh, P.T.T. and Furukawa, M., 2007. *Impact of sea level rise on coastal zone of Vietnam*. Bulletin-college of Science University of the Ryukyus, *84*, pp.45.

Vien, T.D., 2011. *Climate change and its impact on agriculture in Vietnam*. Hanoi University of Agriculture, J. Issaas, *17*(1), pp.17-21.

Zeidler, R.B., 1997. Continental shorelines: climate change and integrated coastal management. *Ocean & coastal management*, *37*(1), pp.41-62.

Date received: 8/9/2018
Date reviewed: 25/9/2018
Reviewer: Assoc. Dr. Tran Danh Suu
Date approved for publication: 25/10/2018

SCREENING OF SALT TOLERANCE POTENTIAL OF A PANEL OF VIETNAMESE RICE LANDRACES AT SEEDLING STAGE

Hoang Thi Giang[*1], Floran Gathignol[2], Le Trong Duc[1], Nguyen Thanh Tuan[3], Gantet Pascal[4,5], Pham Xuan Hoi[1], Lebrun Michel[4,6]

Abstract

In the present study, thirty three Vietnamese rice landraces at seedling stage were evaluated for their salt tolerance at five salinity levels of 0 mM, 100 mM, 150 mM, 200 mM, and 250 mM NaCl. Plants were grown in hydroponics with salt application at the fourth leaf stage. Salt tolerance score, survival rate and dry weights of shoot and root were measured at 7 and 14 days of stress. The results showed that increasing salinity level from 0 to 250 mM caused an obvious decrease in seedling growth of all tested Vietnamese rice landraces. At 7 days of stress, most genotypes exhibited a salt tolerance ranging from tolerant to moderately tolerant with increasing salinity. After 14 days, salt stress caused deleterious effect on almost all genotypes, especially at 200 and 250 mM, where no salt tolerant genotype were observed. At 100 mM NaCl treatment for 14 days, the lines Pokkali, G138 were noted to be the most tolerant and twenty other genotypes were ranked as moderately tolerant. At 150 mM, G138 and G45 were evaluated to be moderately tolerant as Pokkali, whereas the others were more susceptible, but less than IR29.

Keywords: Salinity, salt tolerance, landrace, growth

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important crops as it is a staple for over 3 billion people in the world, especially in the Asia-Pacific region. With the continuous increase of the population, global food production has to double by 2050 to meet

[1] Agricultural Genetics Institute, National Key Laboratory for Plant Cell Biotechnology, LMI RICE-2, Hanoi, Vietnam
[2] IRD, Université de Montpellier, LMI RICE-2, Hanoi, Vietnam
[3] VNUA, Faculty of Agronomy, Department of Genetics and Plant Breeding
[4] University of Science and Technology of Hanoi, LMI RICE-2, Hanoi, Vietnam
[5] Université de Montpellier, IRD, UMR DIADE, 34095 Montpellier, France
[6] Université de Montpellier, IRD, UMR LSTM, 34095 Montpellier, France
[*] Corresponding author: Hoang Thi Giang. Email: nuocngamos@yahoo.com