EVALUATION AND SELECTION OF RICE LANDRACES FOR EARLY DROUGHT TOLERANCE

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ABSTRACT The changing of the world weather, which causes drought period, affects the growing of rice in Thailand. Rice has environmental adaptation in order to growing which is good characteristic and variation among cultivars. Therefore, the objectives of this study are to evaluate and select rice landraces for early drought tolerance. Randomized complete block design (RCBD) with 3 replications was constructed with 2 conditions which were drought stress and well irrigated conditions. Early drought stress was performed at 28 days after planting for 25 days. Photosynthesis and transpiration were determined at 0, 3, 6 and 9 days under drought condition (DUD). The results showed significant difference ($p<0.05$) between 2 conditions at 9 to16 DUD. The highest photosynthesis score which seem to be drought tolerance cultivars was Khao Rai followed by Siw Gling, Leum Pua and Hommali Dang. Transpiration of local rice showed significant difference ($p<0.05$) between stress and well irrigated conditions. The low level of transpiration was detected in Hommali Dang, Sakon nakhon and Khao Rai which indicate to high adaptation in drought condition. Leaf rolling and death leaf had significant difference in cultivars ($p<0.05$). The low leaf rolling score were Khao Rai (1.00), Hommali Dang (1.67) and Leum Pua (2.67). Death leaf showed lowest score in Hommali Dang followed by Khao Rai (2.00) and Leum Pua (2.67). The highest leaf recovery was Hab Hak (6.33) followed by Leum Pua (7.00) and Hommali Dang (7.00). The results showed that Khao Rai, Hommali Dang, Leum Pua and Howm Korat have low level of leaf rolling and death leaf resulting in high leaf recovery which was possibly as early drought tolerance rice. This research revealed that Khao Rai, Hommali Dang, Leum Pua and Howm Korat have early drought tolerance which was applied for further rice development and increasing rice yield under drought condition.

INTRODUCTION

Rice is important resources to specify the behavior, custom, and culture of human. At present, the rice growing in Thailand was affected from the changing of the world weather. Even though the products are decrease, the demands are increase three types of rice growing in Thailand, which classify by geographical, are the growing of rice in irrigation area, the growing of rice depends on rainwater and the growing of rice in upland area. Even though the growing of rice in highland and the growing of rice depends on rainwater are different as the area, both of these use the rain for growing. Besides, upland rice can grow together with sugar cane, rubber tree. Therefore, upland rice is the main foods for people more than 100 million in Asia as well as in Thailand, where upland rice mostly grows in Northern and North East (Sritoomma, 2009).

According to the changing of the world weather, it cause the drought period. Some study report that there have dry spell in July when is the time of begin growing rice of the agriculturist (Narenut, et. al., 2013). Therefore, in this period, there are not enough of the total numbers of the water or the moistness in land. For growing, there are the respond process and adaptation of rice for unsuitable environment. Since the respond is different, it depends on how intense and timing of lacking of water. Besides, the drought period also causes antioxidant or reactive oxygen species which can destroy the molecule of substance: DNA, Protein, plasma membrane and the structure of plant cell. Moreover, reactive oxygen species can causes the death of plant cell (Yong and Juny, 1990), the growing of plant and

decreasing of plant product (Cushman and Bohnert, 2000). When the mineral elements content of rice landraces in Thailand were characteristics, chemical process, and gene are in the drought, there will collect solutes which no harmful to cell: Proline, Alcohol sugar, Glycine. Also, these solutes play a main role that keeping the balance of water in cell (Kongsodsup and Pattanagul, 2012). Rice responds drought stress by rolling their leaf for decrease the loss of water. After facing the drought period for so long, rice leaf will permanent dry, and when rice lose water in cell more, rice tissue will die soon. Therefore, if plants can save more water in cell, the death of leaf will decrease. And if there is less water in cell, the efficiency of chlorophyll will decrease and it causes the decreasing of photosynthesis. Therefore, we interest to study rice landraces which have drought tolerance for further development.

MATERIALS AND METHODS

1. Evaluation of rice landraces for drought tolerance

Local rice was collected from Nakhon Ratchasima Rajabhat University Herbarium including Leuang Rai, Hab Hak, Howm Korat, Sakon nakhon, Khao Rai, Leum Pua, Hommali Dang and Siw Gliang (drought tolerance). Then, rice samples were planted under two conditions which were stress (at 28 days after planting) and well irrigated using RCBD (Random Complete Block Design) experiment according to previous report (Gomes and Gomes, 1984; Narenut, et. al., 2013). The experiments were constructed at Nakhon Ratchasima Rajabhat University on August to November, 2015.

Photosynthesis and transpiration were measured by using LCi-SDUltraCompact Photosynthesis according to instruction manuals after 0, 3, 6, 9 and 16 days under stress condition (Drought) and well irrigated (Control).

Leaf rolling and death leaves were analyzed using method of De Datta et al, 1988. Leaf rolling was analyzed at 10 and 14 days under drought condition (DUD). Death leaf was analyzed after 17 DUD. The results of leaf rolling and death leaf were indicated as scores which were values of 1 to 5 and 0 to 9, respectively. After 25 days under stress condition, rice samples were treated with water in ranged of 10 days to determine leaf recovery. Leaf recovery was determined according to IRRI (1991) method.

2. Data Analysis

The variance of characteristics that get from RCBD experiment was analyzed and compared by DMRT (Duncan's Multiple Range Test).

RESULTS AND DISCUSSIONS

1. Photosynthesis and Transpiration of rice landraces

There is no difference of photosynthesis in local rice in both the groups of stress condition (Drought) and well irrigated (Control) at 0 to 6 days of stress condition (Figure 2) because of remaining of moistness in soil. However, drought and well irrigated condition had significant difference ($p<0.05$) at 9 to 16 DUD. The reduced photosynthesis also was detected on drought condition in various cultivars. The moistness in soil is lower that the capacity field so it clearly suggested that the groups of well irrigated showed higher photosynthesis values than drought condition. The drought tolerance has variation among different cultivars. Khao Rai showed small reduced photosynthesis values which seem to be drought tolerance cultivars followed by Siw Gling, Leum Pua, Hommali Dang, Sakon nakhon, Howm Korat, Hab Hak and Leuang Rai. For the transpiration, local rice under stress condition showed reduced transpiration compared with control. Transpiration of local rice showed significant difference ($p<0.05$) between stress and well irrigated conditions. Drought condition results in adaptation of rice for growing. Hommali Dang and Khao Rai were revealed high adaptation in drought condition among all of cultivars and related with photosynthesis data. Drought stress affected to photosynthesis and transpiration mechanism. We suggested that genotype also affected to drought tolerance.

2. Study of Leaf rolling, Leaf death and Leaf recovery in rice landraces

The results were shown in Table 1 and Figure 2. There are five scores of leaf rolling examination by De Datta et al. (1998). The leaf rolling has determined at 10 DUD that cause decreasing of moistness in soil. Therefore, the soil moistness is lower than the field capacity so it is hard for rice to absorb water. Thus, for decreasing transpiration, rice adapts by roll its leaf. There are some types of rice that even though it has soil moistness lower than capacity field but it doesn't roll its leaf. Local rice showed high leaf rolling score when get long time of drought condition (14 DUD). Suggesting, drought stress affected to leaf rolling which can be used to select drought tolerance rice. The local rice had a significant difference ($p<0.05$) in cultivars. Interesting, the local rice which had low leaf rolling score were Khao Rai (1.00), Hommali Dang (1.67), Leum Pua (2.67) and Howm Korat (3.33) which were possibly as early drought tolerance rice. Death leaf showed score in ranged of 1.67 to 8.33 (Table 1 and Figure 22). There were significant difference ($p<0.05$) observed among cultivars. Hommali Dang showed lowest score which present low death leaf followed by Khao Rai (2.00), Leum Pua (2.67) and Howm Korat (5.67). The recovery leaf varied from 7.00 to 9.00. The highest leaf recovery was Hab Hak (6.33) followed by Leum Pua (7.00), Hommali Dang (7.00), Howm Korat (7.00) and Khao Rai (7.66). Death leaf have positive relative with the rice recovery. The types of rice that slowly recover tend to have higher number of the death leaf, in contrast, rice that have lower number of the death of leaf have a good ability of recover (Narenut et. al., 2013).

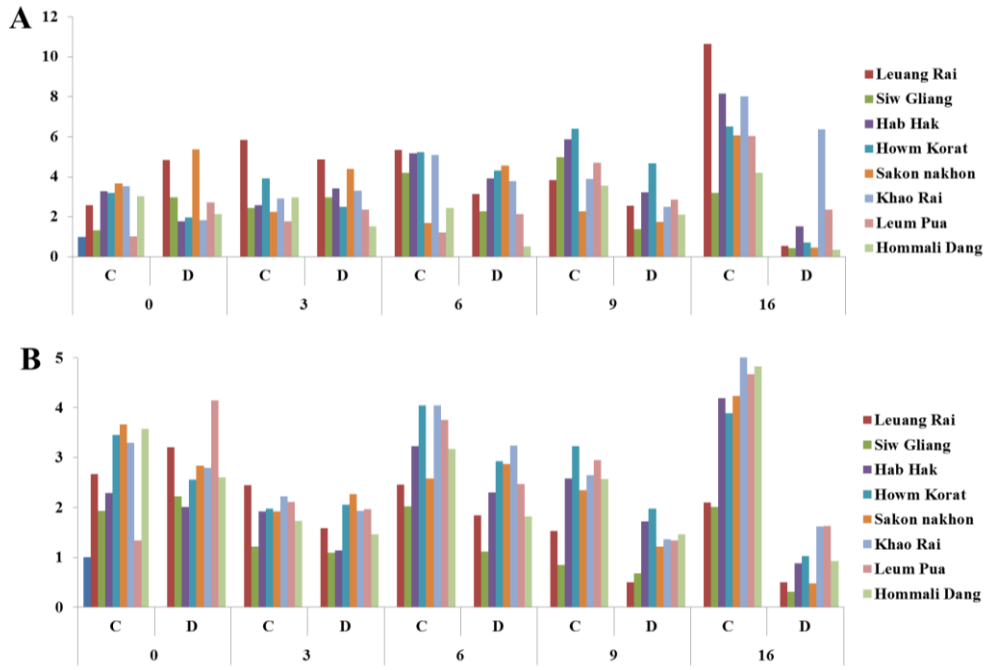

Figure 1 Evaluation for drought tolerance of rice landraces by photosynthesis (**A**) and transpiration analysis (**B**) at 0, 3, 6, 9 and 16 DUD. The alphabet C and D represent as Control (well irrigated) and Drought (stress), respectively.

Table 1 Characteristics under drought condition of rice landraces

Code	Local name	Leaf rolling score (1-5)[1]		Death leaf score	Recovery score
		10 DUD	14 DUD	(1-9)[2]	(1-9)[3]
NRRU01	Leuang Rai	2.33 ab	5.00 c	8.33 d	9.00 a
NRRU02	Hab Hak	3.67 bc	4.67 c	6.67 cd	6.33 a
NRRU03	Howm Korat	1.33 a	3.33 b	5.67 c	7.00 a
NRRU04	Sakon nakhon	2.33 ab	4.67 c	8.33 d	9.00 a
NRRU05	Khao Rai	1.00 a	1.00 a	2.00 ab	7.66 a
NRRU06	Leum Pua	1.00 a	2.67 b	2.67 b	7.00 a
NRRU07	Hommali Dang	1.00 a	1.67 a	1.67 ab	7.00 a
NRRU08	Siw Gliang	4.67 c	4.67 c	6.67 cd	9.00 a

[1]* 1= resistant, 5=susceptible

[2]* 1 = resistant, 5=susceptible

[3]* 1= resistant, 5=susceptible

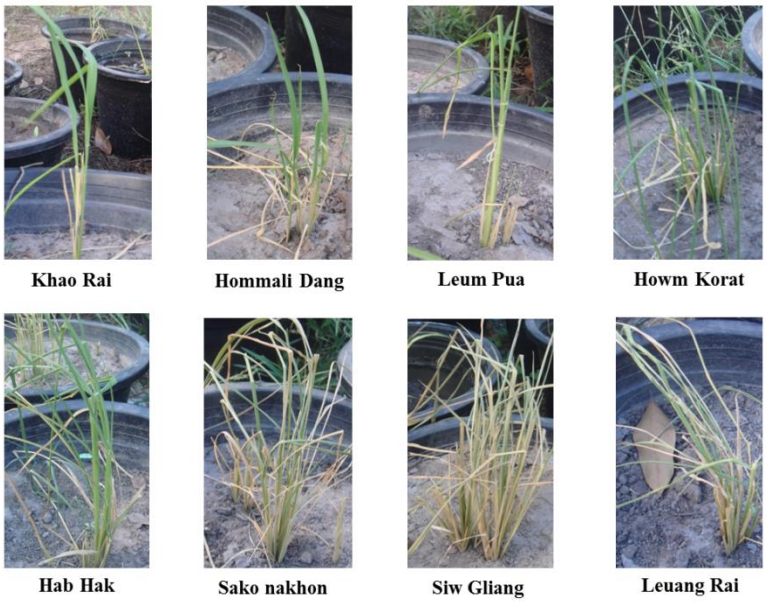

Figure 2 Leaf death of rice landraces analysis at 17 days under drought condition (DUD)

CONCLUSION

Evaluation of local rice for drought tolerance suggested that Khao Rai has highest drought tolerance followed by Hommali Dang, Leum Pua, Howm Korat, Hab Hak, Sakon nakhon, Sakon nakhon, Siw Gliang and Leuang Rai. These results could be applied for rice development, rice planting under drought stress which could be enhancing rice yield for demand of human.

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REFERENCE

Cushman, C. J., and Bohner, J. H., Genomic approaches to plant stress tolerance, *Curr Opin Plant Biol*, vol. 3, pp. 117-124, 2000.

De Datta, S.K., Malabuyoc, J.A. and Aragon, E. L. A., Field screening technique for evaluating rice germplasm for drought tolerance during the vegetative stress. *Field Crops Res*, vol. 19, pp. 123-134, 1988.

Gomes, K. A. and Gomes, A. A., Statistical Procedures for Agricultural Research. MG Reprographics for IRRI in Philippines, 1984.

IRRI., Standard evaluation system for rice, Inter -national Rice Research Institute. Manila Philippines.

Kongsodsup, S,. and Pattanagul, W., Effects of seed priming with Abscisic Acid and Paclobutrazol on germination and growth of rice (*Oryza saltivar*) under drought stress, *Graduate Research Conference. BMO1, KHONKEAN UNIVERSITY,* pp. 401-409, 2012.

Narenut, K., Songsri, P., Pattanagul, W., and Snitchon, J., Early drought tolerance evaluation of indigenous upland rice germplasm, *KNON KAEN AGR. J.*, vol. 41, pp. 643-648, 2013.

Sritoomma, K. Study on potential of local upland rice cultivars for sustainable agricultural system at Chalemprakiat Nan Province, *The Master of Education Degree in Science Education, Srinakharinwirot University*, 2009.

Yong, C. B., and Jung, J., Water deficit induced oxidative stress and antioxidative defenses in rice plants, *J Plant Physiol*, vol. 155, pp. 255-261, 1990.

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