EARLY DETECTION OF LOCAL UPLAND RICE RESISTANCE TO DROUGHT

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ABSTRACT

Agricultural land extension is directed to marginal areas with tipical restrictions such as drought, requiring evaluation to identify genetic sources that can be used to produce drought-resistant varieties. This study aims to determine the resilience of some local upland rice cultivars in the germination phase. The research was conducted at the Laboratory of Seed Science and Technology of Agriculture Faculty of Tadulako University from November 2016 to January 2017. Using a Completely Randomized Design of two factors, the first factor consisted of eleven local upland rice cultivars, the second factor consisted of four levels of osmotic pressure: 0, -1, -2, and -3 bar, so that there were 44 treatment combinations repeated four times, thus there were 176 experimental units. Rolled paper test (UKDdp) was used to germinate the seeds, each treatment was comprised by 50 seeds. The observed variables included germination potential, germination ability, radicle length, plumula length, radicle dry weight, dry weight of plumula, root volume, germination rate and free proline. The results showed that each cultivar gave a different response to the given osmotic pressure. Cultivars of dogan, raki, kelendeng and uta are local upland rice cultivars that have resistance to dryness in the germination phase.

Keywords: drought resistance, local upland rice

BACKGROUND

Rice is a staple food for most Indonesians. Population growth in Indonesia is increasing every year 2% causing increased production of rice crops should continue (Sadimantara & Muhidin, 2012). During this time, the national rice production is mostly still produced from the island of Java. On the other hand, agricultural land on Java is shrinking due to several things and one of them is the conversion of agricultural land to non-agricultural land. According to Priyono (2011), land conversion from agricultural land to non-agricultural land reaches 59,167 ha per year. This condition leads to fertile land which is mostly contained in the island of Java is shrinking so that the future of agricultural land should be directed to the outer island of Java.Agricultural land located outside Java allows to be developed into future agricultural land. However, most agricultural land outside Java consists of marginal or sub optimal land or dry land.According to Mulyani *et al.*, (2016), dryland in Indonesia is 144.5 million ha and of the area 133,7 million ha is dry land with wet climate and 10.8 million ha dry land withdry climate. Much of the wet dry land is included in the dry land of 104.6 million ha and 29.1 million ha is non-acid dry land (Sofyan *et al.*, 2015).

Central Sulawesi province has been a sample dry land covering an area of 1,252,886 ha (Syafruddin *et al.*, 2015), and has potential for the development of food crops (Mulayani *et al.*, 2014). The extent of the dry land provides an opportunity to be planted with local upland rice. Upland rice is one type of rice crop that can be grown on dry land. According to Rahayu and Harjoso (2010), dry land has little water availability so that upland rice grown on dry land should have drought tolerant properties. This is due to the drought will limit the growth and production of cultivated crops (Al-Ashkar *et al.*, 2016) which exceeds that of other environmental stresses (Zu, 2002).

Plants that experience drought will give a specific response. According to Thoruan-Mathius *et al.* (2004) in the face of drought stress, the plant can perform the osmotic mechanism that begins with changes in osmotic sugar, especially in sugar silosa, then induced low molecular weight protein. Furthermore, plant tissue will respond to drought stress by means of production and accumulation of amino acids, especially proline. In addition, under the stress of drought stress, the accumulation of sugar in crops also increased (Mostajeran & Eichi 2009). Guo *et al.* (2012) suggests that along with a decrease in osmotic potential, accumulation of proline and betaine increases in roots and buds. The decrease in osmotic in cells can cause the plant to maintain turgor so that physiological and biochemical processes remain normal in the state of drought stress.

The response of plants to drought originates from physiological responses which are a series of processes in plants, followed by morphological changes both, as a mechanism of plant resistance and the impact of drought stress-induced processes. Morphological changes also affect the physiological process changes continued, resulting in mutual influence between the two. These changes are expressed in the form of plant growth patterns that affect the biomass weight, yield and crop components (Sujinah & Jamil, 2016).

Plants that are tolerant to drought stress will exhibit different physiological responses compared to sensitive plants so that crop response to drought is tolerated on tolerance and sensitivity. There are several criteria of plant resistance to drought that can be seen from the nature of root owned (Kadir, 2011, Sadimantara & Muhidin, 2012) or through root penetration test and seed germination (Shitole and Dhumal, 2012; Pandey & Shukla, 2015; Swain *et al.*, 2014). Some researchers have conducted research on the resistance of rice plants to drought at germination stage (Lum *et al.*, 2014; Yari *et al.*, 2012; Choi, *et al.*, 2000). In conducting screening of labor-resistantdrought resistance, researchers generally use polyethylene glycol (PEG) as a selection method.

Polyethylene glycol (PEG) has been used to control the potential of water in seed germination studies to assess the tolerance of plant drought at the stage of germination and breeding (Dodd & Donovan, 1999). Potential water can be controlled appropriately with this method and a large number of treatments can be done quickly. PEGs with a molecular weight of 6000 or higher can not enter the pores of plant cells and PEG is not toxic to plant cells (Verslues *et al.*, 2006).This compound is an osmotic compound for the treatment of water stress in plants (van der Weele *et al.,* 2000). Ibrahim (2011) has reported that PEG can regulate the potential of water. The use of PEG solution is aimed at obtaining a homogeneous selection pressure so that the identification of sensitive individuals as tolerant of drought stress can be avoided (Hemon *et al.*, 2012). Thus, this study aims to determine the resilience of some local upland rice cultivars to drought in germination phase.

MATERIALS AND METHODS

The research was conducted in the laboratory of Seed Science and Technology Faculty of Agriculture of Tadulako University, from October to December 2016. The seeds used were the result of exploration in 2015 in Sigi, Buol Toli-Toli, Banggai and Tojo Una-Una which consist of 11 cultivars Dogan, Siang, Pulut Ko, Roda, Logi, Raki, Kenari, Kelendeng, Sina Didi, Sina Pondang, and Uta and Polyethylene glycol (PEG) 6000.

This research was arranged with two factors of factorial pattern using Completely Randomized Design (RAL). The first factor consisted of 11 local upland rice cultivars, Dogan (K1), Siang (K2), Pulut Ko (K3), Roda (K4), Logi (K5), Raki (K6), Kenari (K7), Kelendeng (K8) , Sina Didi (K9), Sina Pondang (K10), and Uta (K11). The second factor consisted of four treatments of PEG 6000 with different osmotic pressure, P0 (0 g PEG L^{-1} H_2O), P1 = -1 bar (82.5 g PEG L^{-1} H_2O), P2 = -2 bar (124.38 g PEG L^{-1} H_2O), and P3 = -3 bar (156.75 g PEG L^{-1} H_2O).Thus there were 44 treatment combinations, each treatment was repeated four times so that overall there were 176 experimental units. Each experimental unit used 50 items, so the total seed used was 8,800.

This study begins by saturating the substrate of the paper with PEG 6000 solution according to the treatment. Then remove the excess water on the paper substrate by using a paper press tool. Raw paper used in each roll as much as one coated with a plastic as a base. Seed germination using test method of rolled paper is incorporated in plastic (UKDdp). To provide selection pressure, then every two days the surface of the paper is given 10 mg of PEG solution (treated accordingly). The observed variables included germination potential, germination ability, radicle length, plumula length, radicle dry weight, dry weight of plumula, root volume, germination rate and the proline free.

The data obtained from the measurement results in each observation variables tabulated, and processed using the analysis of variance. To determine the effect of each treatment on the variables observed using F-Test (Fisher-Test). A 5% BNJ advanced test was used to determine the response of each cultivar to the use of different osmotic pressure (PEG)

RESULTS AND DISCUSSION

The results of the variance analysis showed that cultivar treatment, osmotic pressure and their interaction had significant effects on all observed variables except the length of non-interacting radicles (Table 1). This means each genotype has a different genetic makeup (Des Marais *et al.*, 2013) and the response of each different cultivar to PEG. The use of osmotic pressure from 0 to -3 bar causes a potential growth ranging from 14.00% to 97.50% for all cultivars. The largest growth potency of Cultivar siang (K2) and K5 (Logi) compared to other cultivars and K10 cultivars (Sina pondang) has the lowest growth potential at 0 bar PEG. The use of PEG to -3 bar produces a potential growth ranging from 14.00 to 85.50%. The decrease of potential growth due to the use of PEG up to -3 bar is the same for the Doga, Raki, Kalendeng and Uta cultivars.

Each cultivar had a different response to the use of PEG and none of the cultivars showed good response to all observed variables (Table 2). The average germination potential of some cultivars given the osmotic pressure of 0 to -3 bar ranged from 8.00 to 97.50%. Growing power of some cultivars at 0 bar of PEG ranges from 57.00 to 97.50% whereas if given osmotic pressure up to -3 bar will produce germination 8.00 to 79.50%. Dogan (K1), Raki (K6), Kalendeng (K8) and Uta (K11) cultivars are no different when osmotic pressure is up to -3 bar compared to controls. The length of the radicles of some cultivars given osmotic pressure ranges from 5.75 to 11.06 cm. The added value of the osmotic pressure given decreases the length of the cultivar radicle. The cultivar response due to PEG was given in the range of 7.27 to 10.00 cm. Sina Pondang cultivar is a cultivar that has the longest value of the lowest radicle at osmotic pressure of 0 to -3 bar.

Table 1. Analysis of the variance of several local cultivars of upland rice

All observed variables	Mean square			Coefficient of variance
	Cultivar (K)	Osmotic pressure (P)	Interaction (K×P)	
Germination potential	24.467**	61. 18**	2.24**	17.63%
Germination abality	22.43**	100.59**	1.89**	20.57%
Radicle length	6.30**	88.34**	0.79^{ns}	19.79%
Plumule length	15.02**	291.09**	2.51**	20.66%
Radicle dry weight	102.78**	188.27**	7.51**	16.77%
Plumule dry weight	44.51**	257.65**	4.93**	20.80%
Root volume	61.65**	349.03**	16.61**	22.60%
Germination rate	11.17**	85.54**	2.51**	14.29%
Free Proline	17.00**	99.25**	1.55*	6.88%

*Note: **=significantly;*=significant; ns=non significant*

The Uta cultivar (K11) has the highest plumule length at osmotic pressure of 0 bar and the second highest when osmotic pressure up to -3 bar. The Roda Cultivar (K4) has the lowest plumule length at 0 bar and the third lowest at osmotic pressure of -3 bar. The use of osmotic pressure from 0 to 3 bars tends to decrease the length of the plumula. The kanari cultivar has the highest dry weight of radicle at osmotic pressure 0 bar and the highest is -3 bar. Sina pondang is a cultivar that has the lowest dry weight of radicles for 0 bar or -3 bar. Uta is a cultivar that has the lowest percentage of low dry weight of radicles followed by Raki and Dogan while other cultivars range from 56% to 92% (Table 2). Sina Pondang is a cultivar that has the lowest dry plumula weight at osmotic pressure of 0 bar to -3 bar (equal to dry weight of radicle). Uta has the highest dry weight of the sixth plumula at osmotic pressure 0 bar and the second highest at -3 bar. Cultivars that experienced a percentage decrease in dry weight of plumula at -3 bar were inconsistent with dry weight of radicles.

The response of cultivars due to the use of low to high osmotic pressure is inconsistent and the higher the osmotic pressure used the root volume decreases. Uta is a cultivar that has the highest root volume at 0 bar but the third is at -3 bar. Dogan, Kenari and Kalendeng cultivars germinate at 2.82, 2.84 and 2.92 days, respectively (0 bar). The fast cultivars germinate at 0 bar are

Table 2. The response to a variety of local upland rice cultivars in different osmotic pressure

Treatm.	GP (%)		GA (%)		RL (cm)		PL (cm)		RDW (mg)		DWP (mg)		RV (ml)		GR		FP (umol/gFW)	
	Mean	PD	mean	PD	mean	PD	mean	PD	mean	PD	mean	PD	mean	PD	mean	PI	mean	PI
K1P0	93,0a		92,00a		10,11b		5,82c		76,28b		167,05b		0,19b		2,86a		2,15a	
K1P1	92,5a	0,54	90,00a	2,17	8,84b	12,61	4,44b	23,71	74,08b	2,88	165,90b	0,69	0,15ab	20,00	3,03a	6,10	2,51b	16,74
K1P2	88,0a	5,38	80,00a	13,04	5,20a	48,57	2,27a	61,00	38,46a	49,57	42,68a	74,45	0,13ab	33,33	4,00a	39,95	2,87c	33,49
K1P3	85,5a	8,06	79,50a	13,59	4,92a	51,34	2,2a	62,20	39,50a	48,21	37,68a	77,45	0,11a	40,00	3,99a	39,48	3,25d	51,16
BNJ 5%	**13,20**		**12,53**		**2,26**		**1,28**		**16,97**		**19,43**		**0,06**		**1,21**		**0,22**	
K2P0	97,5b		97,50c		12,67c		4,87c		119,85b		273,00c		0,58b		3,90a		2,01a	
K2P1	91,5b	6,15	85,00c	12,82	11,12bc	12,27	2,74b	43,84	102,78b	14,25	144,18b	47,19	0,55b	4,35	5,11ab	31,11	2,25a	11,94
K2P2	68,0b	30,26	55,00b	43,59	8,02ab	36,70	1,78ab	63,45	100,60b	16,06	87,63ab	67,90	0,15a	73,91	5,06ab	29,78	2,31a	14,93
K2P3	18,5a	81,03	11,50a	88,21	4,87a	61,60	0,68a	86,14	21,33a	82,21	45,94a	83,17	0,08a	86,96	6,46b	65,57	2,42a	20,40
BNJ 5%	**31,01**		**26,49**		**3,96**		**1,37**		**44,33**		**63,39**		**0,13**		**1,41**		**0,53**	
K3P0	94,5b		94,50b		10,33b		5,68c		132,33c		173,33c		0,40c		3,18a		2,10a	
K3P1	88,5ab	6,35	83,00b	12,17	8,68b	15,97	3,28b	42,34	95,18b	28,07	121,38b	29,97	0,23b	43,75	4,56b	43,58	2,30ab	9,52
K3P2	79,0ab	16,40	67,00ab	29,10	6,44a	37,66	1,98ab	65,23	50,80a	61,61	69,25a	60,05	0,10a	75,00	4,90b	54,05	2,35ab	11,90
K3P3	60,5a	35,98	41,50a	56,08	5,43a	47,43	1,77a	68,84	30,83a	76,71	50,20a	71,04	0,08a	81,25	4,66b	46,46	2,65b	26,19
BNJ 5%	**29,58**		**32,84**		**2,10**		**1,61**		**31,06**		**37,96**		**0,07**		**1,21**		**0,39**	
K4P0	96,0b		96,00c		11,46b		5,13b		63,43b		109,13b		0,14b		3,35a		2,20a	
K4P1	91,0ab	5,21	85,50bc	10,94	9,35ab	18,38	2,58a	49,76	64,00b	-0,91	76,45a	29,94	0,14b	0,00	3,74a	11,78	2,40ab	9,09
K4P2	71,5ab	25,52	55,50ab	42,19	7,55a	34,13	2,03a	60,49	38,28a	39,65	54,85a	49,74	0,07a	50,00	4,65b	39,06	2,50ab	13,64
K4P3	56,0a	41,67	41,00a	57,29	6,285a	45,13	1,98a	61,37	27,63a	56,44	51,83a	52,51	0,07a	50,00	6,30c	88,27	2,74b	24,55
BNJ 5%	**36,69**		**37,02**		**3,70**		**0,81**		**10,85**		**30,01**		**0,06**		**0,72**		**0,35**	
K5P0	97,5c		97,00b		10,49b		4,15c		141,53b		242,73b		0,63c		3,16a		2,10a	
K5P1	93,0bc	4,62	88,00b	9,28	10,45b	0,43	2,93b	29,52	128,18b	9,43	187,98b	22,56	0,45b	28,00	4,54ab	43,91	2,45b	16,67
K5P2	76,0ab	22,05	58,00a	40,21	8,25ab	21,40	1,81a	56,51	62,75a	55,66	102,60a	57,73	0,13a	80,00	5,00bc	58,53	2,55b	21,43
K5P3	67,5a	30,77	47,50a	51,03	7,14a	31,98	1,64a	60,48	52,20a	63,12	76,48a	68,49	0,15a	76,00	6,75c	113,77	2,61b	24,29
BNJ 5%	**17,17**		**17,56**		**3,20**		**1,05**		**55,83**		**64,27**		**0,16**		**1,52**		**0,30**	
K6P0	92,00b		92,00b		11,74b		4,44a		113,05b		79,62b		0,45b		3,09a		2,21a	
K6P1	85,00ab	7,61	82,00b	10,87	10,62ab	9,58	3,36a	24,35	107,13b	5,24	39,58b	54,51	0,25a	44,44	3,81ab	23,29	2,56ab	15,84
K6P2	75,00ab	18,48	61,00a	33,70	9,61ab	18,14	2,32a	47,80	104,98b	7,14	45,71ab	45,44	0,15a	66,67	4,40b	42,29	2,76bc	24,89
K6P3	71,50a	22,28	52,00a	43,48	8,36a	28,79	1,92a	56,82	59,08a	47,74	38,64a	53,82	0,15a	66,67	5,18c	67,53	3,01c	36,20
BNJ 5%	**17,09**		**14,60**		**3,12**		**2,65**		**11,41**		**24,64**		**0,13**		**0,75**		**0,36**	
K7P0	95,00b		95,00b		11,06b		3,19c		159,83b		239,3c		0,60d		2,84a		2,20a	
K7P1	92,00b	3,16	86,50b	8,95	10,38ab	6,11	2,88c	9,73	179,78c	12,48	174,87b5	26,92	0,35c	41,67	3,34a	17,62	2,35ab	6,82
K7P2	89,50b	5,79	79,00ab	16,84	8,75ab	20,90	2,24b	29,83	159,10b	0,45	163,9a	31,51	0,23b	62,50	3,52a	24,11	2,56b	16,36
K7P3	55,50a	41,58	42,50a	55,26	5,98a	45,95	1,07a	66,56	76,63a	52,06	64,25a	73,15	0,13a	79,17	5,73a	101,84	2,71c	23,18
BNJ 5%	**12,39**		**40,13**		**4,51**		**0,54**		**14,81**		**21,76**		**0,09**		**1,93**		**0,28**	

Table 2. The response to a variety of local upland rice cultivars in different osmotic pressure

Treatm.	GP (%)		GA (%)		RL (cm)		PL (cm)		RDW (mg)		DWP (mg)		RV (ml)		GR		FP (umol/gFW)	
	Mean	PD	mean	PD	mean	PD	mean	PD	mean	PD	mean	PD	mean	PD	mean	PI	mean	PI
K8P0	96,50a		96,50b		10,85a		6,58b		78,13b		215,65b		0,55c		2,91a		2,11a	
K8P1	88,00a	8,81	84,00b	12,95	9,94a	8,43	4,43ab	32,65	71,35b	8,67	136,58ab	36,67	0,28b	50,00	3,67a	25,98	2,55b	20,85
K8P2	87,00a	9,84	78,50ab	18,65	7,73a	28,80	3,075a	53,30	65,45b	16,22	114,00a	47,14	0,15a	72,73	3,60a	23,65	2,65b	25,59
K8P3	67,00a	30,57	52,00a	46,11	6,44a	40,69	2,66a	59,61	42,10a	46,11	86,83a	59,74	0,10a	81,82	4,97b	70,68	2,96c	30,81
BNJ 5%	**36,59**		**31,56**		**4,62**		**2,22**		**13,93**		**82,55**		**0,06**		**0,85**		**0,20**	
K9P0	77,50b		72,50b		12,27c		6,21c		68,40b		125,23c		0,18b		3,83a		2,01a	
K9P1	61,50ab	20,65	54,00ab	25,52	10,92bc	11,01	3,32b	46,49	68,15b	0,37	77,65b	37,99	0,15b	14,29	4,62ab	20,61	2,25ab	11,94
K9P2	47,50ab	38,71	34,00a	53,10	7,28ab	40,64	1,73a	72,12	54,88b	19,77	57,75ab	53,88	0,10a	42,86	5,05b	31,93	2,29b	13,93
K9P3	37,50a	51,61	31,00a	57,24	4,61a	62,45	1,46a	76,55	25,58a	62,61	33,93a	72,91	0,08a	57,14	4,75ab	24,13	2,38b	18,41
BNJ 5%	**36,59**		**33,42**		**4,24**		**1,40**		**17,89**		**34,69**		**0,04**		**0,98**		**0,34**	
K10P0	64,50c		57,00c		9,3c		4,98c		39,93d		79,30c		0,13b		3,11a		2,00a	
K10P1	39,00b	39,53	30,00b	47,37	7,9bc	14,74	2,76b	44,52	28,38c	28,93	43,63b	44,99	0,10b	20,00	3,83ab	23,17	2,12ab	6,00
K10P2	17,75a	72,48	12,50ab	78,07	4,7ab	49,78	1,66a	66,73	10,10b	74,70	10,15a	87,20	0,05a	60,00	4,16b	33,81	2,30b	15,00
K10P3	14,00a	78,29	8,00a	85,96	3,2a	65,12	0,77a	84,62	3,00a	92,49	4,85a	93,88	0,05a	60,00	4,15b	33,51	2,39b	19,50
BNJ 5%	**20,54**		**18,93**		**3,29**		**1,09**		**4,11**		**32,71**		**0,03**		**0,8**		**0,32**	
K11P0	85,50a		83,00a		11,43b		7,41c		103,50b		181,33c		0,65b		3,20a		2,26a	
K11P1	83,50a	2,34	76,50a	7,83	10,86b	4,99	3,89b	47,50	102,48b	0,99	150,60bc	16,94	0,23a	65,38	3,97ab	24,13	2,56b	13,27
K11P2	69,50a	18,71	60,00a	27,71	7,75a	32,24	2,585a	65,11	2,85ab	10,29	104,56ab	42,33	0,18a	73,08	4,26bc	33,17	2,79c	23,45
K11P3	68,00a	20,47	51,50a	37,95	6,37a	44,27	2,31a	68,83	69,85a	32,51	85,10a	53,07	0,10a	84,62	4,74c	48,27	3,01c	33,19
BNJ 5%	**33,08**		**33,17**		**2,99**		**1,18**		**23,68**		**50,4**		**0,14**		**0,80**		**0,22**	

Note: The numbers represented by the letters on the same line are not significantly different at the 5% BNJ test level; GP = germination potency; GA=germination ability; RL= radicle length; RDW=radicle dry weight;DWP=dry weight of plumule; RV=root volume; FP=free proline; PD=percentage decrease; PI=percentage increase inconsistent when gripped up to -3 bar. At high stress (-3 bar) Dogan, Pulut Ko and Sina Pondang respectively have faster germination value. Dogan is a cultivar that demonstrates consistency in this case because it can germinate quickly either given stress or not. Uta (K11) and Raki (K6) each have the first and second highest prolin values at 0 bars and the second highest prolin content at -3 bar. Dogan (K1) has the fourth highest proline content at 0 bar and highest in osmotic pressure -3 bar. Growing plants will produce an increased proline level. At -3 bar stress, the content of dogan cultivar proline increased 51.16%, Uta, Kalendeng and Raki respectively 33.19%, 30.81% and 36.20%. The increase of other cultivar proline content is below the value of the three mentioned cultivars.

DISCUSSION

From the results of the study showed that none of the cultivars showed the best appearance on all observed variables. The use of osmotic pressure up to -3 bar has not caused the seeds to die or not to germinate. The higher the stress (PEG) given will decrease the germination of rice seeds unless the free proline is increased. This is because the PEG molecule is too large to be absorbed by the plant roots, thereby increasing the PEG concentration in the surrounding medium causing movement of water out of plant cells (Mohammadkhani *et al.*, 2008). Thus plant cells experience water stress situations (Hamayun *et al.*, 2010).

The results showed that of the 11 cultivars used there were eight that had the potential to grow and the germination power was reduced by the increased osmotic pressure used. These results are consistent with studies conducted by some researchers that high PEG concentrations reduce the percentage of late germination of lentils (Siahsar *et al.*, 2010; Jamaati-e-Somarin & Zabihi-e-Mahmoodabad, 2011; Muscolo *et al.*, 2014; Turk *et al.*, (2004), the percentage of germination of paddy seeds decreases with the decrease of PEG osmosis potential (Pirdashti *et al.*, 2003) as well as corn crops (Khodarahmpour, 2011). This condition occurs because the increased PEG concentration reducing water uptake by seeds resulting in decreased germination (Haq *et al.*, 2010). The Dogan, Raki and Uta cultivars have the ability to make turgor adjustments when water shortages are able to withstand water shortage.

Root length is an important feature of drought on crop varieties. In general, varieties with longer root growth have resistance to drought (Leishman & Westoby, 1994). Increased osmotic pressure up to -3 bar causes the length of radicles and plumula to decrease. This decrease is different between cultivars and percentage decrease in length of radicles and plumula for cultivars of Dogan, Raki, Kalendeng and Uta below 50% while other cultivars decrease above 50%. The results of this study are similar to Gamze *et al.*, (2005) findings, that the length of radicles and plumulas decreases with increasing osmotic stress in pea plants. The decrease in root length values with increased PEG concentrations has also been found by Jajarmi *et al.* (2009) for wheat, tomato (Basha *et al.*, 2015) and rice (Adachi *et al.*, 2014) plants.

The dry weight of the plumula is higher than the dry weight of the radicle and the dry weight will decrease if the osmosis pressure is added. This shows the cultivar response to the dry weight of the plumula and the taped radicles with PEG differed from one cultivar to another. The decrease in dry weight due to the use of PEG has been reported by (Mohammadkhani & Heidari, 2008) on upland rice. The decreasing plumule dry weight due to increased osmotic potential has also been reported by (Pirdashti *et al.*, 2003). The percentage decrease of dry weight of plumula for cultivar uta is lower than other cultivars. In addition, the percentage decrease in dry weight of radicles for cultivar uta, dogan and raki is lower than that of other cultivars.

The root volume shows the mass or weight of plant roots. The larger the root volume the longer or thicker the roots of a plant. The increased use of PEG in this study causes the root volume to decrease. High osmotic pressure causes water uptake by slow seeds which inhibit root/root activation (Murillo-Amador *et al.*, 2002). The results of Adachi *et al.* (2014) study on rice plants are in line with the results of this study. In this study the percentage of low root volume decrease is found in the cultivar uta while the percentage decrease in other cultivars above 50%.

Proline is a compatible solute and is involved in cell osmotic adjustment (OA) as well as protection of cell components during dehydration (Zhang *et al.*, 2009). Osmotic adjustments help maintain cell turgor, which allows cell enlargement and plant growth during water pressure; and may allow the stomata to remain at least partially open and CO2 assimilate to continue the potential for the inhibiting water (Alves & Setter, 2004). Proline also serves as a free radiclescavenger and suppresses free-radicle damage during drought stress. Several studies have shown that proline content increases during drought stress, and the accumulation of proline is associated with increased crop tolerance to drought (Seki *et al.*, 2007; Zhang *et al.*, 2009).

Observed in the study that increased osmotic pressure up to -3 bar caused the proline content to increase. The accumulation of proline is the adaptive response of the plant during the tap water. The ability to accumulate proline in this study differs between cultivars. Dogan, Raki, Kalendeng and Uta cultivars accumulate more proline than any other cultivar at osmotic pressure up to -3 bar. These three cultivars accumulate proline with an increase of 30,81-51,16% while other cultivars are only 18.41-26.16%. According to Kumar *et al.*, (2011) and Rahdari *et al.*, (2012) the high proline content in plants suffering from drought stress is an indicator of drought tolerant plants.

Determination of drought resistance of each rice cultivar in the laboratory stage would be difficult and confusing to do if none of the cultivars showed a good response to all observed variables. In such situations, selection should be made by looking at cultivars that do not show any real difference when given osmotic pressure from 0 to -3 bar. Based on this assumption, it is seen that the dogan cultivar has the same response if osmotic pressure is up to -3 bar on 3 properties (growth potential, germination and germination rate). Raki exhibits the same properties for one trait (length of plumula), Kalendeng for 2 properties (growth potential and length of radicles) and cultivar Uta on 2 properties (growth potential and germination). In addition, these four cultivars showed an increase in free proline levels above 50% when given osmotic pressure up to -3 bar.

CONCLUSION

The local upland rice seeds can still grow up to the osmosis pressure of -3 bar. The increased osmotic pressure will decrease the potential for growth, germination ability, radicle length, plumula length, radicle dry weight, dry weight of the plumula, and the root volume, otherwise will increase the rate of germination and free proline levels. Dogan, raki, kalendeng and uta are local upland rice cultivars that are resistant to drought in the germination phase .

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