International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Character Evaluation of Upland Rice Varieties on Various Water Provision Levels

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Abstract

This study aims to determine the efficiency of water use between genotype and identify the characters of upland rice varieties tolerant to drought stress. The experiment was conducted in a plastic house in North Aceh, in January 2015 to May 2015. The study design was split plot design with three replications and two treatment factors. The first factor is drought stress (C) which consisted of 4 capacity airy levels namely: C1: 20%, C2: 40%, C3: 60% and C4: 80%. The second factor is the 10 upland rice varieties which consists of three groups, namely (tolerant group varieties) which consists of Ciapus, Inpago 4, and Inpago 8; (moderate group varieties) which consist of Inpago 5, Situ Bangendit, Inpago7, Towuti; and (susceptible group varieties) which consists of Inpari 6 Jete, Inpari 33 and Sintanur. The results of the study showed changes in character of dry root weight and ratio of canopy, number of panicles per clump1000, grains and grain production per clump as a result of drought stress at 20% of field capacity (C1). Tolerant varieties (Inpago 4, Inpago 8, Ciapus) shows avoidance mechanisms to drought stress by increasing weight of dry root, reducing the ration of canopy and decreasing the number of 1000 grains and grain production is smaller and stable.

Keywords: varieties; upland rice; the level of water provision.

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1. Introduction

Climate change causes uneven rainfall distribution during the growing season and reduced effective rainfall causes heavy drought periods. Therefore, controlling the use of water is a major factor to be pay attention to in rice cultivation techniques in dry land.

Technology in varieties is most easily adopted technology because the technology is inexpensive and its use is practical [1].

Rice is a very susceptible to damage crop due to water shortages. Water availability is a major limiting factor in crop cultivation. In tolerant to drought stress crop varieties, the decline of yield due to stress is not as big as that occurs in susceptible varieties that the use of tolerant varieties has significance in the cultivation of plants in anticipation of drought stress conditions [2].

Upland rice varieties are source of genetic material that can be used to study the varieties with a code that can be used to study the varieties that have characters who play a role in tolerance to drought stress. Sensitivity of rice to drought stress increases when, at some point of time, the anthesis occurs which causes sharp declines of grain yield [3].

The response of plants to drought stress can be analyzed through the identification of the characters that play an important role in drought tolerance. This study aims to determine the efficiency of water use and identify the character of morphology, physiology and yield of upland rice varieties which are tolerant to drought stress.

2. Method

2.1 Place and Time

The experiment was conducted in a plastic house in North Aceh, from January 2015 until May 2015.

2.2 Materials and Tools

The plant material used in this study was 10 varieties of rice seeds based on the recommendations of the results of the previous study which also consisted of three groups of varieties:

Tolerant group (Ciapus, Inpago 4 and Inpago 8) moderate group (Inpago 5, situbangendit, Inpago 7 and Towuti), and sensitive groups (Inpari 6 jete, Inpari 33 and Sintanur). North Aceh topsoil land, manure fertilizer, Phonska compound fertilizer + Urea (300 kg / ha + Urea 200 kg / ha), Dithan M 45, Curater 2G, DL-Proline polybag size 40 cm x 50 cm. Tools used include: tensiometer, digital thermometer, meter, hype, digital scales, mortal, pestle, beaker, test tube, bath, lights spritus, stirrer, leaf area meter and microscopes, speed chlorophyll, label, signage and all tools 277orroborating the research.

2.3 Research Design

The design of the study is a randomized group design with three replications, with two treatment factors, namely

The first factor is the variety (V) divided into 3 groups of varieties (the results of the first trial screening); they are tolerant group consisting of (Ciapus, Inpago Inpago 4 and 8), moderate group consisting of (Inpago5, Situ Bangendit, Inpago7 and Towuti), and susceptible group consisting of susceptible varieties (Inpari 6 JATE, Inpari 33 and Sintanur).

The second factor is the drought (C) which consisted of 4 levels of soil moisture content level, namely: C1: 20% of field capacity, C2: 40% of field capacity, C3: 60% of field capacity and C4: 80% of field capacity

2.4 Work procedures

2.4.1 preparation of the land

Top soil land is wind dried and smoothed. Soil sieved with a 3 mm sieve. Later, it is filled into 10 kg polybag. Before use, soil is analyzed both its physical and chemical properties in the laboratory. Initial step before the study is to determine the conditions of field capacity by using the gravimetric method.

This method is done by spraying water on medium until saturation then later letting all the water to drip from the polybag. A planting medium that will be used initially wind dried and smoothed by grinding and sieving of 3 mm. Land that has been finely mixed with cow manure at a dose of 10 tonnes per ha, compound fertilizer Phonska + Urea (300 kg / ha + Urea 200 kg / ha), then media is inserted into a polybag measuring 50 cm x 40 cm.

2.4.2 Plant Preparation

For uniformity of germination, the seeds is put into the oven for 72 hours at a temperature of 43 0C. After roasting, seed seeds weighed as much as 35 g each of the varieties of rice seeds then soaked in a mixture of Dithan M 45 as much as 2 g / l and Curater 2G as much as 0.1 g. Dithan M 45 is required to prevent late blight. While 2G Curater needed to prevent pests found in the soil such as worms and bedbug ground. Seeds are then soaked into mixture of seed treatment plus enough water for 24 hours. 5-6 seeds eggs which have undergone treatment are inserted 2-3 cm deep per polybag.

2.4.3 Thinning

Thinning is done 2 WAP (Week After Planting). 2 homogeneous and the best growth plants are left per polybag.

2.4.4 Maintenance

Maintenance of the plant including eradication of pests and diseases is done by using insecticide Baycarb with a concentration of 0.5 to 1 l / ha. Frequency of spray carried out in accordance with the state of pests and diseases. Weeds that grow in polybags intensively revoked.

2.4.5 Sprinkling

Previously, watering is given every morning as much as 4 mm / day and treatment of drought is done for 1 month.

2.4.6 Drought Treatment

Drought treatment on the plant is conducted at the age of 4 weeks after planting until harvest time, by providing water using gravimetric method. To maintain the amount of groundwater in accordance with the treatments, each treatment soil is measured every day by using tensiometer by plugging into the soil to a depth of 10 cm, and then to restore the water lost by evapotranspiration amount of water is added in accordance to the amount of water lost.

3. Results

3.1 Dry weights Ratio Heading Roots and Root

Group varieties at 20% of field capacity (C1) indicated reduced root dry weight when compared to 4 Inpago varieties tolerant group and 40% of field capacity (C2), with 60% of field capacity (C3) and controls. Susceptible group varieties showed the lowest root dry weight.

The highest root dry weight are those of tolerant varieties Inpago 4 followed by susceptible group varieties Inpari 33 in the control treatment. This shows that the difference between groups avoidance mechanisms tolerant varieties are relatively small reduction in root dry weight due to drought in the group of susceptible varieties are relatively larger.

Root elongation and root dry weight will affect the balance of the root header. increase in headline root ratio is highest in the susceptible group varieties Inpari 33 in the control group and the lowest is tolerant Inpago 4 at 20% of field capacity (C1) (Table 1).

This is due to drought that occurred in Inpari 33 adds to a faster growth of crop top (header) than the growth of the roots, causing root header value ratio is higher.

Meanwhile, drought stress at 20% of field capacity (C1) has lower to header growth than the roots, causing lower root ratio value.

3.2 Number of Panicles per Clump

Drought treatment 20% (C1) of field capacity caused a decline in the number of panicles. Some plants even did not produce panicles at all in susceptible group varieties. Similar issues were also found at moderate group varieties of Inpago 5 and Inpago 7, and tolerant group varieties Ciapus. Inpago 4 (sensitive) and inpari 33 (sensitive) in the control treatment showed the highest number of panicles. (Table 2)

3.3 1000 Grain Grain and Grain Production per clump

Reduced number of panicles, number of grains per clumps and growing number of empty grain have negative implications to the weight of 1000 grains and grain production.

Drought stress at 20% of field capacity (C1) also caused a decline in 1000 grains and grain production per clump but tolerant group varieties of Inpago 4 was able to deliver 1000 grains and good production compared to the moderate and sensitive groups.

1000 grains and the highest production seen in the group of tolerant varieties Inpago 4 and followed sensitive groups Inpari 33 in the control treatment. (Table 3).

Table 1: Average root dry weight (g) and Root heading ratio 10 upland rice varieties due to drought stress

	Drought Stress							
Varietas	**C1 (20% KL**		**C2 (40% KL)**		**C3 (60% KL)**		**Control**	
Bobot Kering Akar								
Ciapus(Toleran)	5.32	l-o	6.00	j-n	7.13	i-k	8.11	hi
Inpago 4(Toleran)	6.44	j-m	6.70	i-l	10.31	fg	17.80	a
Inpago 8 (Toleran)	5.82	j-o	6.62	i-l	7.51	ij	11.77	d-f
Inpago 5(Moderat)	5.62	k-o	5.95	j-o	5.83	j-n	11.77	d-f
SituBangendit (Moderat)	5.99	j-n	9.65	g	10.26	fg	10.42	fg
Inpago 7(Moderat)	5.17	l-o	9.21	gh	5.36	l-o	9.213	gh
Towuti(Moderat)	5.08	l-o	5.32	l-o	6.42	j-m	11.42	ef
Inpari 6 Jate(Peka)	4.21	o	4.77	m-o	11.39	ef	13.11	cd
Inpari 33(Peka)	4.60	no	4.76	m-o	12.51	c-e	16.35	b
Sintanur(Peka)	4.51	no	4.50	no	12.37	c-e	13.66	c
Ratio Tajuk Akar								
Ciapus(Toleran)	1.99	q-s	2.49	l-r	3.00	h-n	4.41	cd
Inpago 4(Toleran)	1.65	s	2.11	o-s	3.27	f-l	4.39	cd
Inpago 8 (Toleran)	1.80	rs	2.26	n-s	2.59	k-r	4.01	c-f
Inpago 5(Moderat)	2.50	l-r	2.72	l-q	3.83	c-g	4.34	c-e
SituBangendit (Moderat)	2.27	n-s	2.65	k-q	2.75	j-q	3.83	c-g
Inpago 7(Moderat)	2.27	n-s	2.33	m-s	3.20	f-l	3.54	f-j
Towuti(Moderat)	2.33	m-s	2.67	k-q	2.93	h-o	3.62	e-h
Inpari 6 Jate(Peka)	2.49	l-r	3.66	e-h	3.69	d-h	4.57	c
Inpari 33(Peka)	3.38	h-k	3.54	f-j	4.01	c-f	6.13	a
Sintanur(Peka)	3.25	f-l	3.29	f-l	3.30	f-l	5.43	b

Description: The figure followed by the same letter are not significantly different based DMRT test at α = 0:05

Table 2: Average Number of Panicles per clump 10 upland rice varieties due to drought stress.

	Drought Stress			
Varieas	**C1 (20% KL)**	**C2 (40% KL)**	**C3 (60% KL)**	**Control**
Ciapus (Toleran)	0.00 o	7.88 i-k	9.96 f-h	11.11 c-g
Inpago 4(Toleran)	4.00 l	7.44 jk	9.88 f-h	14.55 a
Inpago 8 (Toleran)	3.33 lm	9.00 h-j	9.89 f-h	12.22 b-e
Inpago 5(Moderat)	0.00 o	3.33 lm	6.63 k	6.33 k
SituBangendit (Moderat)	2.00 mn	6.33 k	7.88 i-k	9.44 f-i
Inpago 7(Moderat)	0.00 o	4.00 l	6.33 k	9.33 g-i
Towuti(Moderat)	1.00 no	7.88 i-k	11.00 d-g	12.66 b-d
Inpari 6 Jate(Peka)	0.00 o	4.00 l	11.22 b-g	12.22 b-e
Inpari 33(Peka)	0.00 o	3.33 lm	11.00 d-g	13.00 ab
Sintanur(Peka)	0.00 o	3.77 l	11.22 b-e	12.89 a-c

Description: The figure followed by the same letter are not significantly different based DMRT test at α = 0:05

Table 3: Average 1000 Grain and Grain Production per clump 10 varieties of upland rice due to drought stress

	Drought Stress			
Varieas	C1 (20% KL)	C2 (40% KL)	C3 (60% KL)	Control
<u>1000 Butir Gabah</u>				
Ciapus (Toleran)	0.00 l	23.92 bc	21.07 d-i	20.32 f-j
Inpago 4(Toleran)	21.22 d-i	24.15 bc	22.25 c-g	22.14 c-g
Inpago 8 (Toleran)	19.95 f-k	23.84 bc	21.88 c-h	21.73 c-i
Inpago 5(Moderat)	0.00 l	22.40 c-g	19.22 i-k	22.57 c-f
SituBangendit (Moderat)	18.21 jk	20.28 f-j	20.74 d-j	20.40 f-j
Inpago 7(Moderat)	0.00 l	20.32 f-j	20.85 d-i	21.03 d-i
Towuti(Moderat)	17.77 k	21.60 c-g	20.92 d-i	20.47 e-j
Inpari 6 Jate(Peka)	0.00 l	21.14 d-i	25.66 ab	25.84 ab
Inpari 33(Peka)	0.00 l	19.25 h-k	23.06 c-e	27.37 a
Sintanur(Peka)	0 .00 l	19.78 g-k	23.17 cd	23.22 cd
<u>Produksi Gabah per Rumpun</u>				
Ciapus (Toleran)	0 .00 t	9.97 q	15.29 mn	17.35 k

Inpago 4(Toleran)	13.47	o	14.44	no	17.35	k	29.67	a
Inpago 8 (Toleran)	10.01	q	10.99	p	14.44	no	26.72	d
Inpago 5(Moderat)	0.00	t	23.44	g-i	25.17	ef	25.45	e
SituBangendit (Moderat)	10.99	p	21.21	j	22.47	i	25.29	ef
Inpago 7(Moderat)	0.00	t	16.28	lm	16.44	kl	24.28	fg
Towuti(Moderat)	8.77	r	10.99	p	17.35	k	22.62	hi
Inpari 6 Jate(Peka)	0.00	t	9.97	q	26.92	d	28.33	c
Inpari 33(Peka)	0.00	t	7.99	r	28.55	bc	29.77	a
Sintanur(Peka)	0.00	t	6.37	s	28.59	bc	29.47	ab

Keterngan: Angka yang diikuti huruf yang sama tidak berbeda nyata berdasarkan uji DMRT pada $\alpha = 0.05$

4. Discussion

Drought stress will cause a decrease in dry root weight at 20% of field capacity (C1). Susceptible group varieties showed the lowest dry root weight. The highest dry root weight were found in Inpago 4 (tolerant). This showed that the difference between groups avoidance mechanisms of tolerant varieties are relatively small reduction in dry root weight as a result of drought stress on susceptible group varieties are relatively larger. Root elongation and dry root weight will affect the balance of the root header. The highest increase in root header in susceptible group varieties was found in Inpari 33 on the control and the lowest was in Inpago 4 (tolerant) at 20% of field capacity (C1) (Table 1). This is due to drought that occurred in Inpari 33 adds to a growing crop header top (header) faster than the growth of the roots, causing root header value ratio is higher. Root’s growth character, root’s length, dry root weight are important characters in the adaptation to drought stress [4]. Tolerant varieties showed the longest roots in water conditions in a state of water deficit of 20% field capacity (C1) while sensitive groups adapted to the conditions of excess water at field capacity of 60% (C3)[5]. states in addition to the differences in the status of water in farming systems also occur differences in root growth and adaptation to drought.

Tolerant group varieties at 20% of field capacity (C1) which showed the highest amount of grain per clumps were found in tolerant varieties Inpago 4. This shows in the case of drought stress-tolerant varieties, the decrease in the number of was grains smaller and stable. Rice is a very sensitive crop to water shortages during the growth and reproductive phase, water shortages will lead to a high drop of 1000 grains and grain yield. The decline in grain yields was due to the reduced panicle formed and the high sterility [6] [7] reported that water stress can derail pollinated pollen for up to 67 percent of the total grains per panicle. When pollination of pollen reaches the ovule longer mikrofil in 1-8 days. Polen can not get out to the surface of flower because it failed to open due to drought stress.

[8] stated that the rice is very sensitive to long drought stress the heading, the drought in the short time that coincides with the phase of anthesis led to decreased production of grain and harvest index drastically compared with controls [9].

5. Conclusion

Changes in the character of dry root weight and root canopy ratio, number of panicles per clumps, 1000 grains and grain production happened as a result of drought stress at 20% of field capacity (C1). Tolerant varieties (Inpago 4, Inpago 8, Ciapus) showed avoidance mechanisms to drought stress by increasing dry root weight, reducing the ratio of root canopy, decreasing in the number of 1000 grains and smaller and stable grain production.

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