

Drought Tolerance in Some of Red Rice Line Based on Morphology at Vegetative Stage

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Abstract— Tests are carried out to obtain red rice lines that are tolerant to drought based on morphological characters in the vegetative phase (49 HSS). The lines used were genetic material from red rice lines which were the result of a cross between local red rice cultivars namely karajut and silopuk cultivars with Fatmawati varieties consisting of 10 lines namely KF42-2-3, KF42-4-2, KF42-7-3, KF42-9-3, KF42-10-2, KF42-13-2, SF122-3-16, SF122-3-30, SF5-25-8 and SF-25-25. This experiment was carried out from January to May 2018 in the greenhouse of the Faculty of Agriculture, Andalas University. This experiment used a Randomized Block Design (RBD) consisting of 3 groups and 10 hope lines that were given drought treatment. The level of damage based on winding, and leaf dryness of the vegetative phase of all lines included in the tolerant category except SF122-3-30 with a somewhat tolerant category. Based on the intensity of leaf rolling consisting of 2 groups, the tolerant group consisted of 2 lines and rather tolerant groups consisting of 8 lines. Based on the leaf drought intensity consisting of 2 groups, the tolerant group consisted of 7 lines and rather tolerant groups consisting of 3 lines.

Keywords— drought, tolerant, drying, red rice

I. INTRODUCTION

Rice (*Oryza sativa* L.) is the main food source of the Indonesian population, therefore an increase in rice production needs to be carried out in line with the increase in population. But a number of problems emerged, including the conversion of agricultural land to non-agriculture (especially paddy fields), pest and disease attacks. As well as the occurrence of global climate change that has a direct impact on the agricultural sector, for example an increase in temperature and carbon dioxide content, changes in rainfall and others (Prinz, 2004). These problems resulted in reduced fertile land for lowland rice cultivation so that rice production was low.

Dry land development is one of the potential in increasing rice production in sub-optimal land. According to Kartawisastra et al., (2012) around 7,083,812 Ha of dry land is potentially untapped, therefore extensification to dry land is a potential option as an effort to meet the need for rice to develop the idea, the right rice cultivar applied to the land is rice drought resistance. Therefore, it is necessary to develop drought-tolerant rice cultivars to anticipate climate change so that it can be utilized maximally on dry land. Drought-tolerant rice can be obtained through a variety of breeding methods, one of them with ordinary crosses (artificial hybridization). Assembling rice in order to assemble and produce high yielding varieties, early maturing and high nutritional quality, through crossing or hybridization has been carried out by crossing Karajut cultivars which are local red rice in West Sumatra having high nutritional value with New Type of Superior Variety (VUTB) Fatmawati who is early maturing and has high production (Swasti and Putri, 2010). The process of forming VUTB is a series of continuous activities, ranging from the selection of germplasm, crossing, selection, yield testing, seeding, to the release of varieties (Tjokrowidjoyo et al., 2006).

The crossing from the parent produces several hope lines that need to be selected to get the candidate varieties that are tolerant to drought stress that are carried out in the vegetative and generative phases. According to Vankateswarlu and Visperas (1987) drought in the vegetative phase affects leaf growth and root growth, while according to Vergara (1995), generative phase drought will reduce yield and rice yield components. There are three stages in the generative phase which are very susceptible to drought, namely the panicle formation stage, pollination / fertilization and seed filling. If the plant experiences drought stress in one of the three stages it can be ascertained that there will be a decrease in grain yield. his study aims to determine the level of resistance of the 10 red rice hope lines in the vegetative and

generative phases based on rolling, shoot dryness and leaf recovery.

II. MATERIALS AND METHODS

This research was carried out in a greenhouse of the Faculty of Agriculture, Andalas University, West Sumatra starting in October January - May 2018. The materials used were 10 lines of hope for red rice, Urea fertilizer (200 g / Ha), SP-36 (75 Kg / Ha), and KCL (75 Kg / Ha). The tools that will be used are buckets, hoes, knives, sickles, scissors, meters, seed beds, analytic scales, plastic blades and glasses. This experiment used a randomized block design (RBD) consisting of 3 groups and 10 hope lines which were given drought treatment so that 30 pots of plants were planted, each of which was planted with a clump / pot. Criteria for drought resistance are leaf rolling rate, leaf dryness level, and healing power with scale according to IRRIs Standard Evaluation System (SES). Scoring sensitivity stress index for scores is calculated by the Fernandez method (Hanum et al, 2010) formula: Drought-resistance criteria i.e. level scrolling leaves, leaves, dryness and power recuperation (Recovery) and the scale of the standard Evaluation System (SES) of IRRIs.

$$P = \sum \frac{(n \times V)}{Z \times N} \times 100\%$$

Description: P: The intensity of leaf damage; n: Number of leaves for each symptom category; V: crop scores for each symptom category; N: the number of leaves observed; Z: highest cropping score

III. RESULT AND DISCUSSION

3.1 Damage level based on leaf rolling

The results showed that in the vegetative phase the lines were divided into two groups with 9 lines included in the tolerant category and 1 line including the somewhat tolerant category. The results showed that there were variations in the level of damage in these lines. This is a different genetic response in each line causing differences in scores due to leaf rolling. However, all lines included in the tolerant category except SF122-3-30 which are categorized as somewhat tolerant. The highest damage value was obtained by the SF122-3-30 line which is a score of 3.7 with a rather tolerant category, while the lowest damage value was found in the lines of KF42-7-3, KF42-10-2 and SF122-3-16 which were 1.7 with tolerant category.

Physiologically different levels of damage in the results of this study are thought to be related to the response of each fan cell to each line tested. According to Zou et al. (2011) the curled leaves occur due to the shrinking of the bulliform cell or fan cell. Fan cells are a series of cells larger than other epidermal cells, thin walls, large vacuoles and water. The function of the fan cell itself is to

protect the underlying tissue so that it does not experience damage due to greater water loss and opening and closing the leaves in the process of rolling the leaves (Zou et al. 2011). The difference in the level of damage caused by leaf rolling is thought to be related to the water content in the leaves. This is in line with the opinion of Tubur (2011) stating that there is a relationship between leaf rolling and leaf water content. The influence of diffusion conductance and leaf rolling is part of the mechanism of drought avoidance in several genotypes. This is related to the ability of plants to extract water from the soil, which is closely related to the root system. The ability to extract water from the soil also determines the status of water in the leaves, where lines that can maintain the potential of leaf water remain high can increase leaf conductance and reduce the level of leaf rolling. The variation between leaf rolling and leaf water potential of each line and possibly due to the influence of osmotic adjustment, lines with high osmotic adjustment tend to increase cell turgor potential in low leaf water potential conditions. Cattivelli *et al.*, (2008) states that this also occurs in other cereal crops.

3.2 Damage level based on leaf dryness

The results showed that the 10th vegetative phase of the line included tolerant group. The value of leaf damage in the vegetative phase ranged from 1.0-2.3 in the tolerant category. The highest damage value was found in SF122-3-30 and SF5-25-8 lines with a score of 2.3 and the lowest value was obtained in the KF42-2-3, KF42-4-2, KF42-7-3, KF42-9- 3, and KF42-10-2 with a score of 1.7. This shows that the lines tested can survive well with drought stress in the vegetative phase. Thus it can be said that all lines are tolerant to drought based on the level of leaf damage.

Based on observations in this study the lines given drought treatment showed that the leaf dryness level had a lower value than the leaf winding score. This is because the leaf rolling rate is more severe than the level of leaf dryness. The leaves first roll in response to the initial dryness, then experience dryness after losing the moisture content of the leaves. therefore it can be said that the level of leaf rolling is directly proportional to the level of leaf dryness. The same cause is thought to be because the water content in the line is lower than other lines so that it is easier to roll and dry the leaves experience severe damage shown by a high score.

Differences in the level of leaf dryness also occurred in the red rice lines tested. Differences in tolerance between lines to drought stress such as indications are expressions of the nature or genetic potential of these lines. According to Sopandie (2014) that each variety can give a different response to the same environmental factors. To express its full and full genetic potential, plants need optimum

environmental conditions. Then it was also stated that optimum environmental conditions could differ between types of plants depending on the diversity of their genetic makeup. Plant tolerance to certain stresses can be influenced by the nature of a variety, both morphology and physiology. Leaf rolling is the initial response of rice plants to drought stress followed by leaf desiccation. According to Tubur (2011) factors that trigger drought that refers to abortion are stomatal closure, leaf rolling, decreased leaf area and light interception.

3.3 Recovery

During healing for 10 days some lines were seen in normal conditions for less than 10 days. Based on the assessment until the 10th day, the lines KF42-2-3, KF42-4-2, KF42-7-3, KF42-10-2 and KF42-13-2 require 9 days to return to normal conditions, while other lines returned to normal on the 10th day of testing. This means that, all lines can return to normal leaf conditions on the 10th day. However, recovery observation cannot be used as an indicator in determining the tolerance level of the line tested. This is because within 10 days the plant has returned to normal before the 10th day, so that the damage level can be observed for more than 10 days.

Based on observations of the level of recovery, showed that the lines tested had a constant response which was very tolerant to drought stress which was able to return to normal conditions within 10 days. This indicates that these lines have the ability to maintain growth in dense conditions (drought). Arrandea (1989) states that the drought recovery mechanism is related to the ability of plants to restore growth after a certain period of drought. Arrandea (1989) states that the drought recovery mechanism is related to the ability of plants to restore growth after a certain period of drought. Fukai and Cooper (1995) added that this mechanism is important when drought occurs at the beginning of plant growth and development, this shows in several genotypes that are able to produce more tillers and produce grain after a period of drought. The ability of plants to improve the metabolic system due to dryness is related to its ability to keep the leaves green during periods of drought. Maintaining the leaves remain green when drought stress occurs during panicle initiation is very important because leaves that remain green provide assimilation for the development of panicles so that the production of spikelet will increase (Tubur, 2011).

3.4 Damage intensity

The level of intensity of damage due to leaf rolling during the vegetative and generative phases can be seen in Table 7. The intensity of damage can be divided into 2 groups, the tolerant group consists of 2 lines and rather tolerant groups consisting of 8 lines. The highest winding intensity is found in SF122-3-30 line which is 41.11%

with somewhat tolerant criteria, while the lowest winding intensity is found in KF42-7-3 and KF42-10-2 lines which are 18.89% with tolerant criteria. The intensity level of damage due to leaf drought is carried out during the vegetative phase can be seen in Table 8. The intensity of leaf drought damage in the vegetative phase can be grouped into 2 groups, namely the tolerant group consisting of 8 lines and rather tolerant groups consisting of 2 lines. The highest intensity is found in SF122-3-30 and SF5-25-8 lines which are 25.56% with somewhat tolerant criteria, while the lowest damage intensity is found in lines with 11.11% intensity. The value of drought damage intensity shows that some lines have different values this is due to differences in the response of each line tested so that there is a difference in damage intensity and criteria for drought stress. Line criteria based on the drought damage intensity of the vegetative phase ranged from 11.11-25.56% with tolerant to somewhat tolerant criteria. The value of the intensity of leaf damage due to leaf rolling and dryness shows that each line tested has a different value. The difference in the value of leaf damage intensity is suspected because differences in plant genetic responses to different water losses will cause different leaf damage intensity. This is also allegedly due to the water content in the line so that it is easier to experience winding which causes the leaves to experience heavy damage, which is indicated by high damage intensity 2 lines including rather tolerant groups. The highest intensity is found in SF122-3-30 and SF5-25-8 lines which are 25.56% with somewhat tolerant criteria (AT), while the lowest damage intensity is found in lines with 11.11% intensity. While the intensity of damage is due to the dryness of the leaves in the generative phase can be grouped into 2 groups with 8 lines including the tolerant category (T) and 3 lines including the somewhat tolerant category (AT). The highest intensity level was found in SF122-3-30 and SF5-25-8 lines, namely 41.11%, the lowest damage intensity was found in SF5-25-25 lines which were 8.89%. The value of drought damage intensity shows that some lines have different values, this is due to differences in the response of each line tested so that there is a difference in damage intensity and criteria for drought stress. Line criteria based on drought damage intensity vegetative phase ranged from 11.11 to 25.56% with the criteria of resistance (T) to somewhat tolerant (AT), whereas in the generative phase ranged from 8.89 to 41.11% with the criteria of resistance (T) to somewhat tolerant (AT).

The value of the intensity of leaf damage due to leaf rolling and dryness shows that each line tested has a different value. The difference in the value of the intensity of leaf damage is suspected because differences in the plant's genetic response to different water losses

will cause different leaf damage intensity. In addition, the SF122-3-16 line has a higher intensity value in the generative phase than the vegetative phase, this is presumably because the genetic response of the line is more sensitive to drought in the generative phase than the

vegetative phase. This is also allegedly due to the water content in the line so that it is easier to experience winding which causes the leaves to experience heavy damage shown by high damage intensity.

Table 1: The scale level scrolling leaves, leaves, dryness and the power of healing according to the standard Evaluation System (IRRI, 2013) in the following table:

Scale	Leaf Rolling	Leaf Drying	Recovery	Kategori
0	Leaves healthy	No symptoms		Very Tolerant
1	Leaves start to fold (shallow)	Slight tip drying	90-100 %	Tolerant
3	Leaves folding (deep V-shape)	tip drying extended up to ¼	70-89%	Rather Tolerant
5	Leaves fully cupped (U-shape)	One-fourth to ½ of all leaves dried	40-69%	Moderate
7	Leaf margins touching (O-shape)	More than 2/3 of all leaves fully dried	20-39%	Rather Susceptible
9	Leaves tightly rolled (V-shape)	All plants apparently dead. Length in most leaves fully dried	0-19%	Susceptible

Table 2: The extent of the damage leaves strain-strain red rice hopes based on scrolling leaves of vegetative and generative phase

No	Lines	Leaf Rolling		Leaf Drying	
		Value	Tolerant level	Value	Tolerant level
1	KF42-2-3	2,3	Tolerant	1,0	Tolerant
2	KF42-4-2	2,3	Tolerant	1,0	Tolerant
3	KF42-7-3	1,7	Tolerant	1,0	Tolerant
4	KF42-9-3	2,3	Tolerant	1,0	Tolerant
5	KF42-10-2	1,7	Tolerant	1,7	Tolerant
6	KF42-13-2	2,3	Tolerant	1,0	Tolerant
7	SF122-3-16	1,7	Tolerant	3,0	Tolerant
8	SF122-3-30	3,7	Rather Tolerant	3,7	Rather Tolerant
9	SF5-25-8	2,3	Tolerant	3,7	Rather Susceptible
10	SF5-25-25	3,0	Tolerant	1,7	Tolerant

Table 3: The old days reached a level of healing until the return to normal conditions line-line of red rice in expectation of vegetative

No	Lines	Vegetative Stage	
		Day	Tolerant level
1	KF42-2-3	9	Very Tolerant
2	KF42-4-2	9	Very Tolerant
3	KF42-7-3	9	Very Tolerant
4	KF42-9-3	10	Very Tolerant
5	KF42-10-2	9	Very Tolerant
6	KF42-13-2	9	Very Tolerant
7	SF122-3-16	10	Very Tolerant

8	SF122-3-30	10	Very Tolerant
9	SF5-25-8	10	Very Tolerant
10	SF5-25-25	10	Very Tolerant

Table 4: recapitulation of the level of Robustness based on leaf rolling and leaf Drying of vegetative leaves

No	Lines	Leaf Rolling		Leaf Drying		Tolerant Level
1	KF42-2-3	2,3	T	1,0	T	Tolerant
2	KF42-4-2	2,3	T	1,0	T	Tolerant
3	KF42-7-3	1,7	T	1,0	T	Tolerant
4	KF42-9-3	2,3	T	1,0	T	Tolerant
5	KF42-10-2	1,7	T	1,0	T	Tolerant
6	KF42-13-2	2,3	T	1,7	T	Tolerant
7	SF122-3-16	1,7	T	1,0	T	Tolerant
8	SF122-3-30	3,7	RT	2,3	T	Rather Tolerant
9	SF5-25-8	2,3	T	2,3	T	Tolerant
10	SF5-25-25	3,0	T	1,7	T	Tolerant

Note : VT :very tolerant; T :tolerant; RT : rather tolerant

Table 5. The intensity of the leaf rolling and leaf drying on vegetative stage

No	Galur	Leaf Rolling		Leaf Drying	
		Damage intensity %	Tolerant Level	Damage intensity %	Tolerant Level
1	KF42-2-3	25,56	Rather Tolerant	11,11	Tolerant
2	KF42-4-2	25,56	Rather Tolerant	11,11	Tolerant
3	KF42-7-3	18,89	Tolerant	11,11	Tolerant
4	KF42-9-3	25,56	Rather Tolerant	11,11	Tolerant
5	KF42-10-2	18,89	Tolerant	11,11	Tolerant
6	KF42-13-2	25,56	Rather Tolerant	14,61	Tolerant
7	SF122-3-16	29,94	Rather Tolerant	11,11	Tolerant
8	SF122-3-30	41,11	Rather Tolerant	25,56	Rather Tolerant
9	SF5-25-8	25,56	Rather Tolerant	25,56	Rather Tolerant
10	SF5-25-25	33,33	Rather Tolerant	21,24	Tolerant

IV. CONCLUSION

The level of damage based on winding, and leaf dryness of the vegetative phase of all lines included in the tolerant category except SF122-3-30 with a somewhat tolerant category. Based on the intensity of leaf rolling consisting of 2 groups, the tolerant group consisted of 2 lines and rather tolerant groups consisting of 8 lines. Based on the leaf drought intensity consisting of 2 groups, the tolerant group consisted of 7 lines and rather tolerant groups consisting of 3 lines.

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