Improvement of Rice Mutants to Drought Stress in Root System, Lignocellulose Production, and Nitrogen Uptake

Riza Meutia[1], Muyassir[2], Efendi[3]

[1]Post Graduate of Land Resources Conservation, Faculty of Agriculture, University of Syiah Kuala, Banda Aceh, 23111, Indonesia

[2]Department of Land Resources Conservation, Faculty of Agriculture, University of Syiah Kuala, Banda Aceh, 23111, Indonesia

[3]Aceh Rice Research Institute, University of Syiah Kuala, Banda Aceh 23111, Indonesia

Abstract: ***Soil fertility needs to be maintained properly in order to produce optimal agricultural production. The drought stress that hit Indonesia decreased rice production. Deficiency of N elements will produce plants not grow well, while excess N will inhibit plant growth. This study aims to determine the production of lignocellulosic biomass and also uptake from several mutant rice strains in drought stress conditions. Split plot design was prepared as the pattern of Group Random Design. The mutant rice strain studied were the lines of Sanberasi-9a, Sanberasi-76, Sanberasi-88, and Inpari 10 Laeya Varieties and IR 64 as a comparison. The study showed that the production of lignocellulosic biomass of mutant rice lines available between 52.34 grams to 60.85 grams per plant under drought stress conditions but would not improve these conditions, also applies to nitrogen uptake. Drought stress can reduce the yield of lignocellulosic biomass in mutant rice lines. There is no real interaction between rice strains and drought stress on lignesululose biomass Keywords: Final manuscript, Guidelines, Instructions, Prospective authors, Template production and nitrogen nutrient uptake.***

Keywords: lignesululose, nitrogen, mutant rice, drought stress

1. Introduction

In order to achieve optimal agricultural production, soil fertility needs to be maintained properly. According to Foth (1), land plays an important role in the success of agricultural production. Plants can grow optimally if the soil has good in physical, chemical, and biological properties. One of the determinants of the success of agricultural production is the nutrient content in the soil. In the other hand, biomass is an organic material produced through photosynthetic processes. Rice straw is a biomass which is chemically a lignesululose compound. The usual biomass potential in Indonesia as energy is very abundant.

Drought occurs as a result of adverse climate change in various sectors, especially the agricultural sector (2, 3). Climate change results in an increase in the temperature of the earth's surface and changes in rainfall patterns and extreme weather (4). Drought is one of the external factors that influence plant growth (5). According to Levitt (6) and Bray (7) drought is a term to state that plants experience water shortages due to limited water from the environment.

The development of new varieties is not only based on high yield and tolerant to environmental stresses, but the quality of rice and the taste of rice produced is another factor that is also important to be considered. The response of plants to drought originates from a physiological response which is a series of processes in plants, followed by morphologically good changes, as a mechanism of plant resistance and the impact of the process due to drought stress. Morphological changes also affect changes in advanced physiological processes, resulting in mutual influence. These changes are expressed by plants in the form of growth patterns which affect the weight of biomass and yield components.

Some researches in Indonesia have proven that fertilization technology is very real affecting the increase in national rice production, especially in the supply of nutrients N, P, and K in nutrient-poor soils (8). In this study researchers used Laeya Inpari 10 Varieties and IR 64 as a comparison. IR64 varieties are one of the lowland rice varieties that are efficient in consuming water. New superior varieties can be obtained from genetic sources of rice originating from local rice varieties. According to Alamsyah (9), local varieties of Aceh Sanberasi after being irradiated with gamma rays at a dose of 250 Gy caused changes in the agronomic characters of mutant rice lines. The mutant rice strain produced by radiation can also increase the yield of high productivity, dry resistance, high temperature resistance (10).

2. Materials and Methods

This research was carried out at the Greenhouse of the Faculty of Agriculture, Syiah University, Kuala Darussalam, Banda Aceh. This research took place from March to November 2016. Rice seeds for this study were obtained from the Seed Laboratory of the Agriculture Faculty of Syiah Kuala University. It was consisting of 2 comparison varieties (Inpari 10 and IR 64) and 3 mutant rice strains (Sanberasi-9a, Sanberasi-76 and Sanberasi-88).

Rice cultivation is done in Green House by using the organic SRI method. The general procedure of the SRI method is implemented as a cultivation technique in the plots. The rice seed is germinated and sprinkled into a tray that contains a 10% sandy loam soil. The 12-day-old seedlings from the nursery trays were carefully cultivated into the experimental plot. Organic fertilizer given is a fertilizer Petroganik with a dose of 10 tons-1 ha. The first weeding is done on 14 days after planting, followed by the second and third weeding at intervals 14 days after the first weeding done. Irrigation is applied with intermittent technique with alternative wetting and drying that is starting from the time of planting to the maximum tillering stage

Root length measurements are carried out at the time after the drought stress treatment is carried out, ie at harvest time. The root length is measured starting from the base of the stem to the longest root tip. Root dry weight was obtained by weighing the roots which had been oven dried at 60°C for 3x24 hours so that the weight was constant. Lignin content was prepared by the method of Klason Method. N Content was analyzed by Kjeldahl Method.

3. Results and Discussion

3.1 Effect of rice lines and drought stress on root systems

The average root length and root weight due to the influence of rice lines at harvest are presented in Table 1. In observing the root length due to the effect of rice strain treatment, the longest root length was found in the Sanberasi 88 strain which was 14.50 cm which was significantly different from the length of the root variety/other rice lines. Whereas in the root weight observation in the treatment of rice lines, the heaviest root weight was found in Laeya Inpari 10 varieties which was 10.20gr cm which was not significantly different from the root weight of the Sanberasi 88 strain of 10.13gr but was significantly different from the IR 64 varieties and other rice lines. The length of the various roots is caused by internal factors and external factors of plants, namely genetic factors and environmental factors grow. Internal factors related to the activity of meristem cells cause an extension of the growth of plant roots and stems. As previously explained, genes affect the speed of cell division of a plant and trigger the formation of deep roots, as well as efficiency in nutrient utilization (Artherburn 11).

Table 1 shows that the lightest root weight at harvest due to the influence of drought stress treatment was shown in very dry conditions of 5.66 gr which was significantly different from the root weight in normal conditions but not significantly different from the root weight in dry conditions. O'Toole et al. (12) stated that a good root system in dryland rice plants is a root system with long roots and quite a lot of roots. Water content factors influence the weight of the root. It is suspected that plants that get limited water from the soil so that the plant will increase the rooting volume, which will affect the dry weight of the roots.

3.2 Lignin and Element N

The average number of lignin and N elements in some rice lines due to drought stress are presented in Table 3. Based on the data shown in Table 3, although drought stress treatments and rice strains did not show a significant effect on the amount of lignin and Element N, drought stress treatment normal conditions caused higher amounts of lignin and N elements compared to dry and very dry conditions. Whereas in the rice strain treatment, the amount of lignin from Sanberasi-9a line was higher than that of the two comparison varieties and other strains and the highest N element was obtained in the Sanberasi 76 line. Fairhust et al., (13) stated that plant N elements are closely related to leaf photosynthesis and crop production. If irrigation and N elements are given sufficiently in other nutrient crops such as P and K elements increase to compensate for the fast growth rate of plants.

3.3 Lignesululose Biomass

The average dry straw on some rice lines due to drought stress is presented in Table 4. Table 4 shows that the highest lignesululose biomass is due to the influence of drought stress, which is normal conditions, ie 60.85 g which is significantly different from dry and very dry conditions. Water shortages affect the physiological and biochemical processes of plants and cause plant anatomy and morphology modification. Decrease in water loss can be done by means of leaf rolling, stomatal closure, decreased leaf water potential, reduction of leaf area, acceleration of leaf loss which will further reduce total photosynthesis and biomass production (14, 15).

4. Conclusion

The production of lignocellulosic biomass from mutant rice strains ranged from 52.34gr to 60.85gr per clump under drought stress conditions but did not significantly affect these conditions, as did the nitrogen nutrient uptake. Drought stress can reduce the yield of lignocellulosic biomass in mutant rice lines. There is no real interaction between mutant rice strains and drought stress on lignocellulosic biomass production and nitrogen nutrient uptake

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Table 1: The average root length and root weight due to the influence of mutant rice lines

Genotypes	Root Length (cm)	Root Weight (g)
Inpari 10 Laeya	12,03 a	10,20 b
IR 64	11,77 a	6,45 a
Sanberasi 9a	12,29 a	4,43 a
Sanberasi 76	12,16 a	6,01 a
Sanberasi 88	14,50 b	10,13 b
BNJ 0,05	2,54	5,33

Legend: The number followed by the same letter in the same column is not real at the level of opportunity 0.05 (BNJ Test).

Table 2: The average weight of rice roots due to the influence of drought stress of rice mutant

Drought Condition	Weight of Root (gr)
Normal	10,41 b
Moderate Drought	7,84 a
Severe Drought	5,66 a
BNJ 0,05	4,55

Legend: The number followed by the same letter in the same column is not real at the level of opportunity 0.05 (BNJ Test).

Table 3: The average number of lignin and N elements in some rice lines due to drought stress effect

Drought Condition	Lignin	N Element (mg/L)
Normal	3,56	2,31
Moderate Drought	3,44	2,20
Severe Drought	3,40	2,17
Genotypes		
Inpari 10 Laeya	3,41	2,27
IR 64	3,47	2,28
Sanberasi 9a	3,49	2,20
Sanberasi 76	3,43	2,31
Sanberasi 88	3,45	2,23

Legend: The number followed by the same letter in the same column is not real at the level of opportunity 0.05 (BNJ Test).

Table 4: The average dry straw on some rice lines due to drought stress treatments

Drought Condition	Biomass Lignesululose (g)
Normal	60,85 b
Moderate Drought	34,43 a
Severe Drought	25,34 a
BNJ 0,05	19,07

Legend: The number followed by the same letter in the same column is not real at the level of opportunity 0.05 (BNJ Test).