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SUSTAINABLE AGRICULTURE DRIVING THROUGH DEVELOPING GREEN GROWTH STRATEGIES

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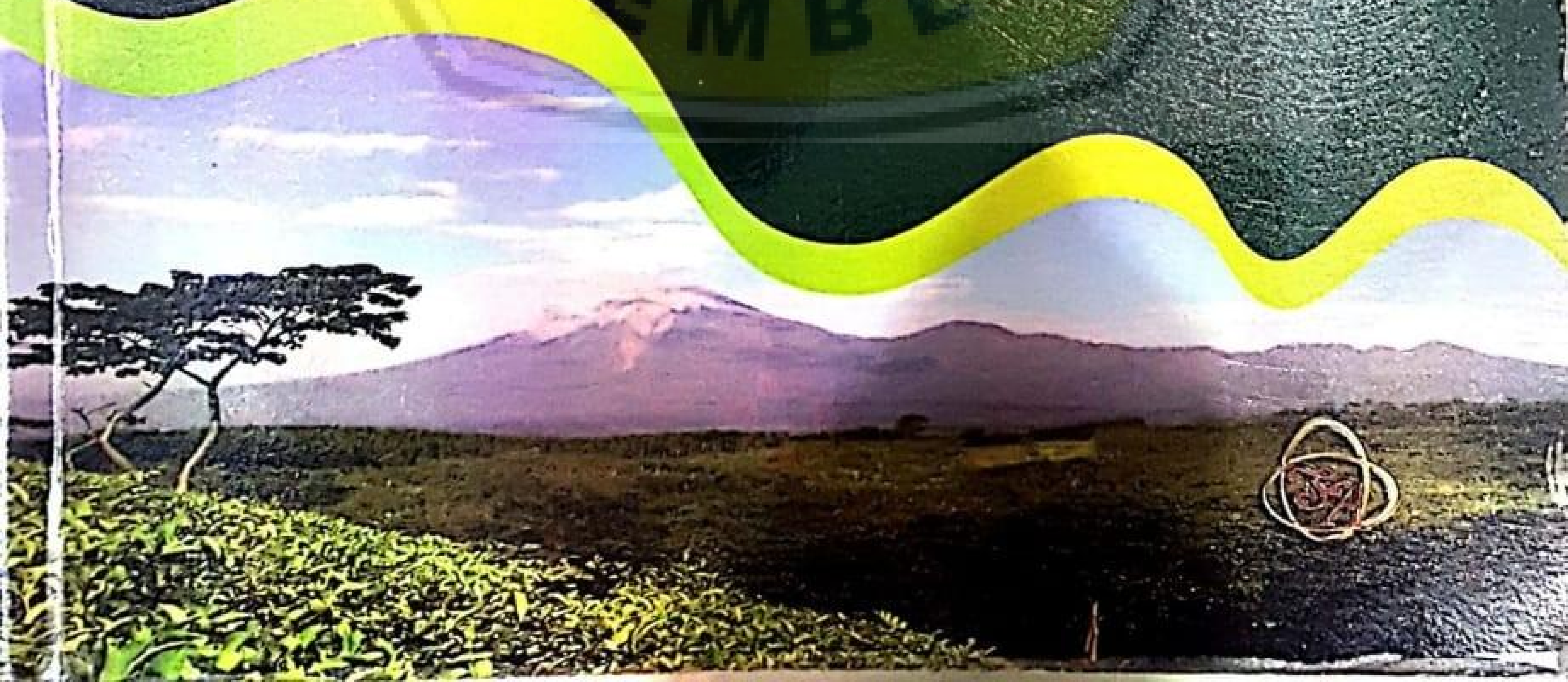

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SEMESTA ANUGRAH

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THE EFFECTS OF FLOODING STRESS ON THE TWELVE VARIETIES OF SUGARCANE (Saccharum officinarum L.)

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ABSTRACT

Parasitic plants live and grow attached to host plants either cultivated or wild. The The flooding land has poor drainage, therefore, it may lead to reduce of crop growth as the result of water stress and limited oxygen supply. In our research, we treated several sugarcane varieties against the excess water condition on the flooding media. The purpose of this research was to evaluate the growth response of different variety of sugarcane under flooding stress condition. The experiments were conducted using Split Plot Design that consist of 2 factors with 3 replications. The main plot consisted of 12 sugarcane varieties: Bulu Lawang, Kentung, Kidang Kencana, PS 851, PS 862, PS 864, PS 865, PS 881, PS 882, PSJK 922, VMC 76-16, PSJT 941. The second factor (sub plot) consisted of flooding stress level: (0, -10, -20, -30) cm under the growth media surface. Data were analyzed by analysis of variance and Duncan's multiple range tests (α, 5%). Our results showed that the flooding stress resistant varieties were PSJT 941, and PS 862, while the susceptible varieties were PS 865 and Kidang Kencana. Among the two resistant varieties, PSJT 941 was shown as the most superior variety against the flooding stress since they able to show the excellent plant height and leaves number during this undesirable environmental condition.

Keyword : flooding stress, marginal land, sugarcane

INTRODUCTION

In 2013, the sugar consumption in Indonesia, had reached 5.5 million tons while the level of domestic sugar production was only 2.76 million tons. To meet the demand, Indonesian government had to import 2.26 million tons of sugar (Lilis, 2013). Therefore, the efforts to increase the production of a sugarcane as raw material for sugar production must be conducted to reduce or stop the import of sugar. One of several efforts that can be applied by creating the new sugarcane plantation on the marginal land (Yuwono, 2009). In Indonesia, marginal lands with the excess of water stress such as the flooded land, submerged land, salin land, and flooded nearby the mining area (Yuniati, 2004).

According to VanToai, et al. (2001) the excess water on land are divided into 2 the condition, such as 1) condition of saturated water (waterlogging or flooding) where the condition of roots are flooded, and 2) complete submergence where some parts of a plant are flooded.

A plant that is capable to adapt to the excess of water stress condition is characterized by their ability to cope with stress by forming the aerenchyma tissue, increase dissolved sugar, increase the activity of glycolysis and fermentation enzymes, and also increase the antioxidants to establish the resistance mechanism against hypoxia and anoxia (Sairam, et al., 2008).

One attempt to overcome the problem of excess water stress on sugarcane cultivation is by selecting the sugarcane varieties that show higher resitance level against flooding stress. Therefore, we conducted a research by examining the tolerance level of twelve verieties of sugarcane against flooding stress. We expect that the selected sugarcane varieties that are able to maintain their high productivity during flooding stress can becultivated in the marginal land with excess of water and participate in the increase of domestic sugar production.

MATERIALS AND METHOD

The experiments were conducted in the Agroteknopark land experiment, UNEJ, Jubung, Kecamatan Sukorambi, Kabupaten Jember, East Java, in July until September 2014. Experiment were designed using split plot factorials with 2 factors and 3 repeatments. The first factor consists of twelve varieties of sugarcane (Bulu Lawang, Kentung, Kidang Kencana, PS 851, PS 862, PS 864, PS 865, PS 881, PS 882, PSJK 922, VMC 76-16, PSJT 941) and the second factor consists of flooding stress level (0, -10, -20, -30) cm under media surface.

Single bud sugarcane seedlings were obtained from P3GI garden collection in Pasuruan. Seedlings were grown in 40x60 cm size of polybag. The growth media fo sugarcane was the mixture of soil, sand, and compost in a 1:1:1 ratio (v/v). Normal daily irigation was given to create a sufficient soil moisture .After plant approximately 40 cm height, the flooding treatments was given to the growth media as assigned. Variable observation used in this study consist of: plants height, leaf number, chlorophyll content, number of internode, internode length, and leaf sucrose level.

RESULTS AND DISCUSSION

Flooding stress results in the impairement of plant metabolism. Metabolic disorders due to the excess water actually caused by deficiency of oxygen, which could decrease the process of growth and development (Chen, Y *et al.*, 2013). In this study, we observed that each of sugarcane variety showed different response under flooding stress. In general, flooding treatment results in the decrease of plants height and induction of chlorosis caused by reduce the chlorophyll content. (Figure 1). We found that the height of sugarcane variety Vmc 76-16 was highest compare to the other varieties (Table 1). This could due to several factors such as VMC 76-16 is suitable in the rice fields with the sufficient of water (Sugiyarta, 2006). Another possibility might be was Vmc 76-16 is capable to fix and restore the damages caused by the flooding stress, which in turn can perform its function normally.

The lowest value of chlorophyll content was shown by VMC 76-16 with an average value 144,9 $mmol/m^2s^1$; while PS 881 showed the highest chlorophyll content with the average value of 216,2 $mmol/m^2s^1$.

The lowest number of internodes was shown by PS 865 variety with the average value of 2.4 whereas the highest number of internodes was shown by variety bululawang with the average value of 6.5 (Table 1). According to Djojosoewatdho (1979) the number of stems internode and the length of stem are the component of production that cannot be separated. Plants with long stems and more number of internode will have high production.

The sucrose contents in the tested varieties after flooding treatment are different (Table 2). Several varieties showed the decrease of leaf sucrose content after flooding treatment (Bululawang, PS 864, PS 882, PSJK 922, dan VMC 76-16) whereas increase of leaf sucrose were observed in Kentung, Kidang Kencana, PS 862, PS 881, dan PSJT 941 varieties.

The stratification of the resistance level of examined sugarcane vareties against flooding stress was performed by classifying the observed phenotype using the range number between 1 to 6. The value of the smallest data given a score of 1 and the highest data give the score of 6 (Table 3).

Our result was in accordance with the research of Kawano, et al., (2009) and Toojinda et al, (2005) that flooding triggers the elongation of stems as one of strategies to escape against excess water stress and help to satisfy the demand of oxygen and carbon dioxide to support aerobic respiration and photosynthesis.

PSJT 941 variety showed the highest number of leaf, while PS 865 showed the less number of leaf (Table 1). According to Sairam, et al., (2009), the insufficient of oxygen because the excess of water is a factor that constraint the plant growth. Lack of oxygen changes the metabolism from aerobic to anaerobic, which results the reduce the number of plant leaf. The leaves of susceptible plant will be desiccated as the result incapability of root to absorb the water and organic element particularly nitrogen.

According to Taiz and Zeiger (2003) chlorophyll play an important role in photosynthesis and influence the product of photosynthesis, that subsequently affect the plant growth. The reduce of photosynthesis and respiration has been observed in the plants with low chlorophyll content although the supply of oxygen and carbon dioxide is sufficient. This condition is therefore decreases the overall aspects of plant production (Setyorini dan Abdulrachman, 2008).

Internode is the storage place of succrose in sugarcane. Sugarcane naturally have some characteristics when subjected to the flooding condition. The sensitive plant varieties are die if it is subjected into flooding condition whereas the tolerant varieties will survive and capable to repair plant organ from the damages. The optimum quantity of water should be suplied to sugarcane plant. The insufficiencies or excess of water results the growth inhibition of sugarcane p. If the water supply is not optimum, length of the stem will be abnormal and eventually lead to the lethality for the sensitive plant. According to Campbell et al., (2004) sucrose is the main product of photosynthesis resulting from the process of carbon assimilatee in leaves. Sucrose is then used as a source of carbon and the source of energy for growth and development of plants, and also it is transported into a sink organ.

Sugarcane varieties with high level of leaf sucrose content indicates the good photosynthesis and metabolism processes. On the other hand, plants with low level of sucrose after flooding indicates the interference of metabolism as shown by the lower content of chlorophyll and sucrose.

The sucrose content in the leaves depends on several factors such as varieties, land conditions, as well as the age sugarcane varities. The level of sucrose in the leaves are not always in line with the growth level of plants. PS 881 and PS 862 varieties with highest leaf sucrose level after flooding stress showed the lower plant height compare to VMC 76-16 and PSJT 941. This result might be explained that PS 881 and PS 862 are classified to have shorter life span than VMC 76-16 and PSJT 941.

The high score was given to the sugarcane varieties that show the best growth level, while the smaller score was given to varieties with the lowest growth. The score 1 represents the susceptible plant while most resistant is represented by 6. Based on the assessment of six parameters, (height of plant, number of leaves, length of segment, number of segment, chlorophil content, and leave sucrose), it was concluded that PSJT 941 and PS 862 are the varieties with higher flooding resistance whereas PS 865 and Kidang Kencana are susceptible.

CONCLUSION

Our results indicate that sugarcane varieties PSJT 941, and PS 862 showed the highest the resistance level against flooding stress, while the susceptible varieties were PS 865 and Kidang Kencana. The -10 cm of flooding stress treatment results the optimum condition for the development of stem internodes and content of leaf sucrose. Finaly, we found that PSJT 941 is the most superior sugarcane variety against the flooding stress as indicated by their excelent plant height and more of leaf number.

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