Response of bululawang sugarcane variety to salt stress

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Abstract. At present, the development of sugar cane is directed at saline land but salinity provides a bad effect on the growth of sugarcane. The impact of salinity on sugar cane plants is hamper its growth and decrease the yield to 37%. This study aimed to determine the response of sugarcane shoots of Bululawang variety to salt stress (salinity). A series of four concentrations of NaCl (0 Mm, 50mM, 100mM and 150 mM) was used to treat 1 week old plantlet. The research was arranged in a complete randomized design with 20 replicates. The results showed that sugarcane growth was inhibited including length of the root, height of shoots, wet and dry roots and shoots weight were decreased by NaCl treatment. Damage symptoms due to salinity were more pronounced at NaCl concentrations above 100 mM.

Keywords: Saccharum sp, Salinity, Salt tolerant,

1. Introduction

Sugarcane (Saccharum sp) is one of important commodities in agricultural sector because sugarcane provide sugar which is consumed by all of people in the world. At the moment, Indonesia sugar production has not fulfilled domestic consumption due to several factors [1]. Increase sugar production can be done by extensification to new land areas. However, the available agricultural land is sub-optimal land, such as saline land [2].

Salinity is defined as the presence of dissolved salt in excessive concentration in soil solution. Salinity is one of serious agricultural problems that result in reduced yields and agricultural productivity [3]. Soil salinity inhibits plant growth and development due to increased osmosis pressure from groundwater, and resulting plant toxicity [4]. One strategy to deal with saline soil is to use high salinity tolerant [2].

Sugarcane plants are classified as non-tolerant plants for salinity checks, because they show symptoms of poisoning due to salinity stress. Several studies reported that 200 mM NaCL inhibited seed germination, caused nutrient imbalance in plant cells and decreased plant growth by 15-86% [5], which eventually reduced crop productivity by 37% in the population of harvested stalks by 37% [6]. Sugarcane shows high sensitivity to salinity stress at various stages of growth. salinity level is measured by Electrical Conductivity (EC). [7] reported an increase in the Electrical Conductivity value of 4–8 dS/m reduced plant height and sugarcane stems by more than 30%. Several other studies also reported a decrease in the components of growth and physiological processes (photosynthesis rate, stomatal conductance and chlorophyll synthesis) of sugarcane due to an increase in the EC value of the soil [8][9]. One way to overcome the problem of salinity is to use tolerant varieties [10].
Bululawang (BL) is a sugarcane variety which is more suitable for light (sandy/clay) soil with good drainage systems and sufficient N fertilization. BL has high potential production (94.3 tons/ha with sugar content 7.51) because it still produce more tillers after 12 months when the plant almost ready to harvest. The purpose of this study was to determine the response of BL shoots to salt stress (salinity).

2. Materials and methods
This activity has been carried out in a greenhouse of the Center for Research and Development of Agricultural Biotechnology and Genetic Resources from January - May 2019. The plant materials used were 10 cm plantlets cultured on MS media for 1 week. Before treatment, the plantlets were acclimated in water medium for a week and then transferred to Gamborg solution. Four days later NaCl solution at concentrations of 0, 50, 100, 150 and 200 mM were added to each pot. Each treatment consisted of 20 pots and considered as replications. Observations were made 14 days after the plantlets were placed in saline solutions. Response of plantlets to salinity stress based on SES (Standard Evaluation Score) [11]. Observations were also done on plant height, root length, number of tillers, wet and dry weight.

| Score | Observation | Tolerance       |
|-------|-------------|-----------------|
| 1     | Normal growth, no leaf symptoms | Highly tolerant |
| 3     | Nearly normal growth, but leaf tips of few leaves whitish and rolled | Tolerant |
| 5     | Growth severely retarded; most leaves rolled; only a few are elongating | Moderately tolerant |
| 7     | Complete cessation of growth; most leaves dry; some plant dying | Susceptible |
| 9     | Almost all plants dead or dying | Highly susceptible |

3. Results and discussion

3.1. Sugar cane response to NaCl stress
BL tended to be sensitive to NaCl stress since symptoms of damage began to appear 4 days after treatment. Scoring of salinity disturbance symptoms on sugarcane was carried out 14 days after NaCl treatment. In general, the NaCl treatment inhibited sugarcane growth. The higher the NaCl concentration, the higher the score of damage (Table 2).

BL variety was still tolerant to 50 mM NaCl. Increasing concentration of NaCl to 100 mM resulted in a moderate response where the plants were stunted and the leaves were curled. Concentration of 150-200 mM caused the plants died. Sugarcane is classified as glyophyte plants means that they show high sensitivity to salinity stress at various stages of growth [12]. Symptoms of salt poisoning are shown as abnormal growth and decreased production which can eventually cause plant death [5][6].

3.2. Effect of NaCl stress on sugarcane growth
In Figures 2 and 3 it can be seen that all of the NaCl concentration tested in this study inhibit plant height and number of tillers, except control. The higher the concentration, the more inhibition occurred and the more number of tiller decreased. Furthermore, some of the growing point of shoots were dry when the plants treated with 100 mM NaCl. As [15] reported that excessive salt on plants generally inhibited plant growth including plant height and number of tillers.
| Con. NaCl | Score | Tolerance     | Observation                                                                 |
|--------|-------|---------------|-----------------------------------------------------------------------------|
| 0 mM   | 1     | Highly tolerant| Normal growth, no leaf symptoms                                             |
| 50 mM  | 3,4   | Tolerant      | nearly normal growth, but leaf tips of few leaves whitish and rolled       |
| 100 mM | 5,4   | Moderately tolerant | Growth severely retarded: most leaves rolled; only a few leaves were able to grow |
| 150 mM | 8,6   | Highly susceptible | Almost all plants dead or dying                                              |
| 200 mM | 9     | Highly susceptible | Almost all plants dead or dying                                              |

**Figure 1.** Sugarcane performance due to salt stress (A) Tolerant (B) Moderately tolerant (C) Highly susceptible (D)
In conditions of salt stress, plants will experience salt poisoning due to high ion concentration and drought stress, and plants will reduce excess water to survive. Discharge of water from plants is mostly done through transpiration through stomata, cuticles and lenticels [13]. Effect of salt stress besides changing metabolic activity and inhibiting growth [14].
Figure 4. Ratio of hoots and root wet weight after being treated with NaCl

Figure 5. Ratio of shoot and root dry weight after being treated with NaCl

The higher the NaCl concentration, getting lower the value of the ratio of wet weight and dry weight of shoots and roots (Figures 4 and 5). Concentration of 100 mM NaCl started to inhibit the growth, the tendency to change the stem and root ratio showed a large decrease. Growth is severely hampered due to the treatment of 100 mM NaCl. The use of NaCl over 100 mM causes the plants to die. Sugarcane treated with NaCl showed damage symptoms such as drying out the growth point and inhibition of root growth. This is because the root meristem cells are sensitive to salt so that the mitotic activity of these cells is inhibited. According to [16] there are two reasons that might underlie the reduction of root growth under salt stress conditions. The first is the loss of turgor pressure for cell growth because the osmotic potential of the media grows lower than the osmotic potential in the cell. The second is cell death.
due to salt confusion. Bululawang varieties cane which experience salt stress can result in growth will be marked with yellowing leaves, lowering plant height and dry weight ratio from shoots and roots.

4. Conclusion
BL was categorized as sensitive to salt stress. All of the tested concentrations of NaCl (except 0 mM) inhibited sugarcane growth, characterized by decreased of plant height, number of tillers and shoot and weight of shoots and roots ratio

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