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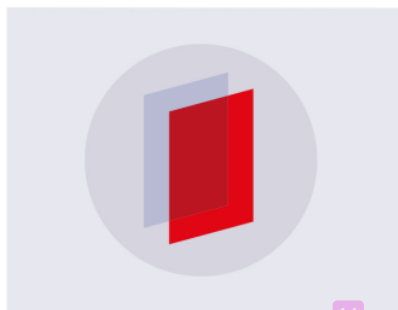
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The influence of altitude of the place on the vegetative growth of several varieties of sugarcane (*saccharum officinarum* L.)

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Abstract. This study is aimed at finding out vegetative growth of some varieties of sugarcane on different altitudes. The study applied Factorial Randomized Block Design comprising two factors. The first factor was varieties of consisting of three levels: BM 13579, Ps. 92-1, and Ps. 89-1. The second factor was altitudes of the land with three different levels of altitudes: Kebun Saentis (15 MASL), district of Pancurbatu (± 300 MASL), and district of Sibolangit (± 700 MASL). The study resulted in that variety of sugarcane, altitudes, and the interaction of both variables affected these: the leaf area on observations of 21, 42, 63, and 84 daps, number of tillers, root volume, nutrient uptake on observation 84 daps. The best quality of the sugarcane varieties was variety Ps. 92-1 on altitude 15 MASL (Kebun Saentis), followed by an altitude ± 300 MASL (district of Pancurbatu), and then on ± 700 MASL (district of Sibolangit); while the worst quality of the variety was variety BM 13579 of altitude 15 MASL (Kebun Saentis).

Keywords: height, location, plant

1. Introduction

Sugarcane (*Saccharum officinarum* L.) is the main source for production of commercial sugar. Sugar is one of the strategic commodities; which is needed by people in Indonesia as basic daily consumption [1]. The need for sugar today is increasing in line with the growing number of people in Indonesia. Meanwhile, some recent years it was reported that the production of sugar has been going down on its productivity [2]. The decrease of this productivity has been caused by not achieving the raw factors of cultivation techniques of the product. One of the determinant factors in sugarcane productivity is the application of superior varieties which is implemented in the arrangement program of varieties based on the suitable typology of land, maturity characteristics, planting time, and harvesting time. The selecting process of the sugarcane varieties should be on attention, because of the limitation of productive time of the superior varieties which lasts only five years, because of the availability of location-specific varieties of sugarcane, and of the difficulty to obtain the introduction of foreign sugarcane [3].

The growing of sugarcane plant is affected by weather condition in a certain place. The height of it very much affects the growing of all plants. When we talk about the height of its/ altitude, it means that it involves the air temperature, sun rays, and air humidity. These aspects affect the growth of all plants. What it means by the height of the land is the height of the land above the level (elevation). The height of the land affects the change of the weather temperature. The higher the place, like



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Mountains, the lower the temperature/ or, the colder the place. In reverse, the lower is the place; the higher is the temperature/ or the hotter is the place.

The regional distinction of topography, geography, and weather cause the existence of differences in plants, planting phase, and methods of cultivating. Constant planting of some plants and the suitable weather will increase the growth of the plant. The height of the place above the sea level determines the temperature and the light intensity which is received by the plant. The higher is the place; the lower is the temperature. Thus the sun ray intensity decreases. Temperature and illumination will be used to categorize which plants are suitable to grow on lowland and highland.

Every variety of plants responds differently toward different temperature and the height of the place and thus resulted in vary phases of growth. Based on this fact, this study was conducted to derive the effect of altitude on vegetative growth of some varieties of sugarcane (*Saccharum officinarum* L.).

2. Methods

This research was conducted in three locations namely in Kebun Saentis on 15 MASL, region of Pancurbatu on ± 300 MASL, and district of Sibolangit on ± 700 MASL.

The study applied the factorial Randomized Block Design, which consists of two factors. The first factor is the varieties of sugarcane: $V_1 =$ BM 13579, $V_2 =$ Ps. 92-1, $V_3 =$ Ps. 89-1. The second factor is the altitude: $H_1 =$ Kebun Saentis (15 MASL), $H_2 =$ district of Pancurbatu (± 300 MASL), and $H_3 =$ district of Sibolangit (± 700 MASL). In total, there were 9 treatments combined, and each treatment was repeated every third time, and thus accumulated 27 combined treatments. If the effect of the treatment is differently real on the variety print (ANOVA), then the further test is continued by using the next distance Duncan test on the level of 5%. Variables observed were the leaf area at observation on 21, 42, 63, and 84 daps, the number of tillers, root volume, and nutrient uptake at observation on 84 daps.

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3. Results and Discussion

3.1. Leaf Area

The leaf area affects the photosynthetic process in producing assimilates. This assimilation affects the vegetative growth of the plant. The transmission of the result of assimilation process to the leaf will grow the leaf bigger and broader. The bigger leaf will allow the plant to have the capability to do photosynthesis. The differences between the three varieties of sugarcane are affected by the genetic factor, different planting of the plants, and also the environment condition [4]. The difference in genetic characteristics also causes the difference in reactive response toward the variety of surrounding conditions, so that growing activities appear different. Three different varieties of sugarcane if planted in the same condition will even grow differently [5].

The effect of the height of the place on the leaf area of some varieties of the sugarcane can be seen in Figure 1.

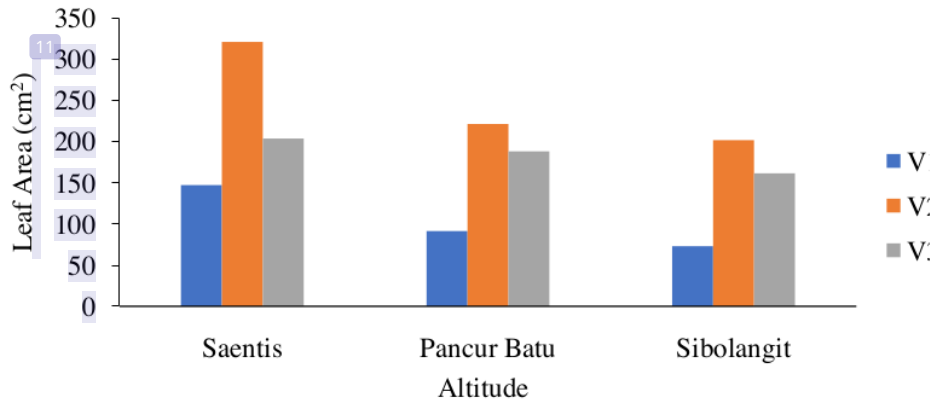


Figure 1. The Leaf Area of Some Varieties of Sugarcane on Different Altitudes of Land, At Age 84 daps

Figure 1 shows that the Ps. 92-1 (V₂) has the largest leaves on those three different heights, followed by a variety Ps. 89-1 (V₃); meanwhile, the smallest leaf of sugarcane is variety BM 13579 (V₁). Those three varieties grow better in lower places.

3.2. The Number of Tillers

Sugarcane plants have the capability of growth to produce tillers in a hill. Budding of tillers is regarded an important cycle in the growth of the plant because at this phase the plant is said to produce good plants or not. The process of budding of tillers is often called *tillering* and lasts when the sugarcane is between 3 or 4 months. In Figure 2 it can be seen that the number of tillers mostly found in a variety Ps. 92-1 (V₂) followed by Ps. 89-1 (V₃) and then BM 13579 (V₁). Variety Ps. 92-1 (V₂) adapts better with every different height of land. It is shown from the number of tillers growing. Tiller of the sugarcane is one of the variables which is important to increase the productivity of the sugarcane. The productivity of the sugarcane per unit of land is determined by the abundant number of tillers formed by the sugarcane [6]. The more is the tillers formed; the more is the harvest of the sugarcane obtained. Tillers of the sugarcane then are the main factor to get the high productivity of the plant [7].

The effect of the height of the place on the number of tillers of the sugarcane in different varieties of the plant is seen in Figure 2.

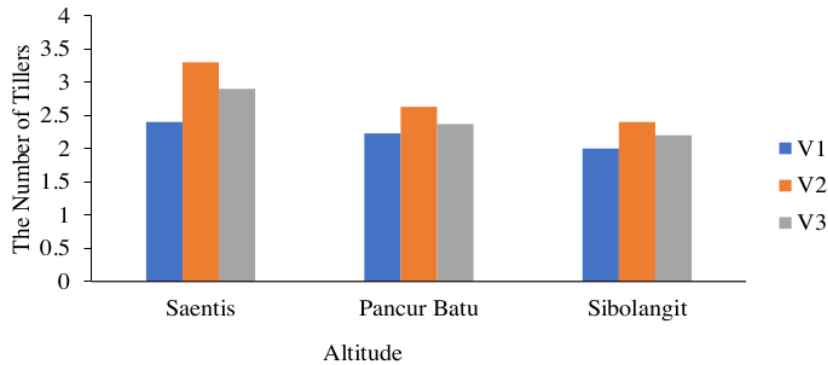


Figure 2. The Number of Tillers in Some Varieties of Sugarcane on Some Different Altitudes of Land, at Age 84

Figure 2 shows that variety of Ps. 92-1 (V₂) has the most number of tillers, which are planted on the three different altitudes, followed by the variety of Ps. 89-1 (V₃), while the fewest number of tillers exist in the variety of BM 13579 (V₁). The three varieties grow better on the lower altitude (Kebun Saentis).

3.3. Root Volume

Roots are the main absorptive element to uptake nutrient, mineral salts, and water from the soil. The growth of roots will positively correlate with the growth of other organs of the plant. The growth of roots can be indicated in their volume. The better is the growth of the roots, the better their capability to reach food nutrient from the soil to suffice the plants' Nutrient needs and the more optimal they will grow. In this study variety 92-1 (V₂) were more adaptive in the lowland, that means that conditions fluctuate with the rainfall, temperature and nutrient availability. Here variety 92-1 (V₂) stays capable of growing better. If the root volume is bigger, so the power to reach nutrient is more regarding absorbing nutrient and water from the soil so that transference through transportation pathway all over the plant tissues will increase [4].

The impact of the height of the land on the volume of sugarcane root in several varieties of the plant can check in Figure 3.

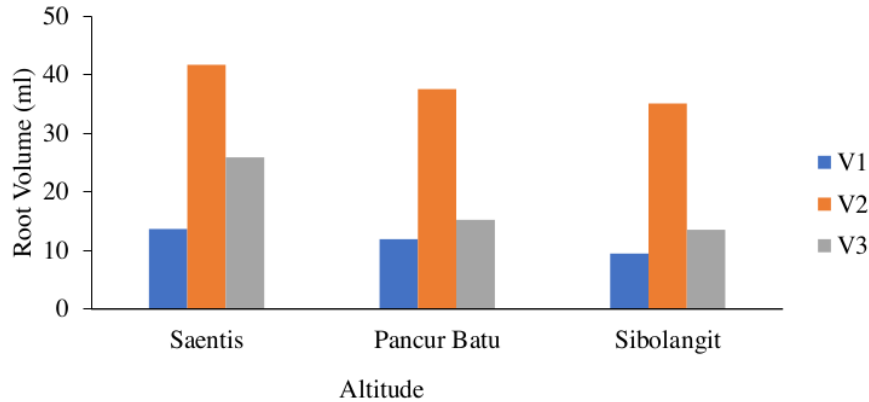


Figure 3. Root Volume of Some Varieties of Sugarcane on Some Different Altitudes at Age 84

Figure 3 shows that sugarcane variety Ps. 92-1 (V_2) has bigger root volume which is planted in the three altitudes, followed by sugarcane variety Ps. 89-1 (V_3), while the least volume of the sugarcane root was variety BM 13579 (V_1). Those three varieties grow better and have bigger root volume on lands which are low (Kebun Saentis).

3.4. Nutrient Uptake N (mg N/ta)

During vegetative phase of the growth, plants need a nutrient element to do metabolism process. The nutrient elements absorbed from the surrounding can make the plants grow leaves, tillers and better root volume, so that photosynthetic process can last more optimally [8]. At germination phase, nutrient uptake is slow. The uptake lasts faster when the roots and leaves grow which is the same time happens in blossoming process. In Figure 4 it can be seen that each highest nutrient uptake N exists in plants planted in the location of Kebun Saentis of variety Ps. 92-1 (V_2) and the slowest nutrient uptake exist in plants planted in a Sibolangit location that is variety Ps. 89-1 (V_3) at observation on 84 daps. Nitrogen is one of the main nutrient elements for plants. Nutrient N is absorbed by the roots of plants and can force vegetative growth like lengthening the branch and enlarging the leaves, making bigger diameter, producing more roots, tillering, and reducing dry leaves. In sugarcanes, nitrogen determines result and quality of the plant because it affects leaf area, leaf area indexes, and leaf area period, closing earlier canopy and photosynthesis speed which all of those can increase biomes production [9].

The impact of the land heights on nutrient Nitrogen uptake of plants like sugarcanes of varieties of sugarcane is seen in Figure 4.

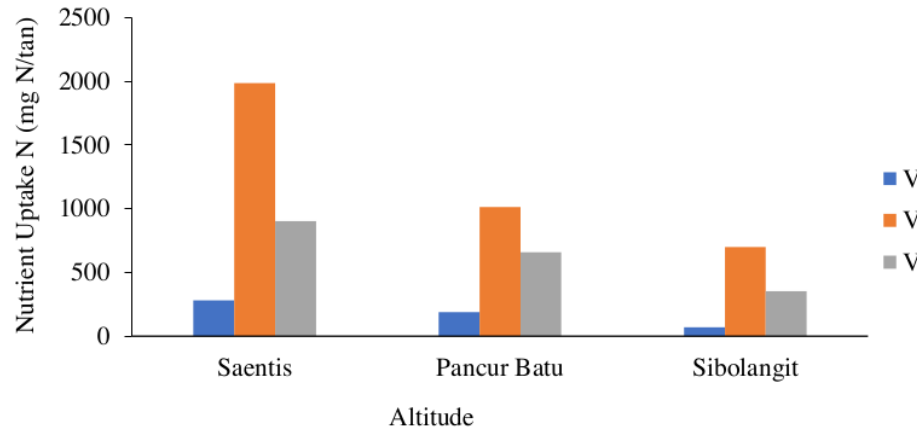


Figure 4. Nitrogen Nutrient Uptake of Some Varieties of Sugarcane on Some Different Altitude of Land, at Age 84

Figure 4 indicates that sugarcane variety Ps. 92-1 (V_2) has Nitrogen nutrient uptake which is higher on those three altitudes of land, followed by sugarcane variety Ps. 89-1 (V_3), while the lowest Nitrogen nutrient uptake exists in sugarcane variety BM 13579 (V_1). Those three varieties of sugarcane have better nutrient uptake when planted on lower lands (Kebun Saentis).

4. Conclusions

1. The heights of the land have a real effect on the vegetative growth of sugarcane. Sugarcane has vegetative growth in Kebun Saentis (15 MASL), followed by in district of Pancurbatu (± 300 MASL), and in district Sibolangit (± 700 MASL).
2. The varieties of sugarcane have a real effect on the vegetative growth of the plant. The sugarcane variety Ps. 92-1 (V_2) has better vegetative growth than variety BM 13579 (V_1) and variety Ps. 89-1 (V_3) do.
3. There happened interactions of altitudes of land with sugarcane varieties and with a vegetative growth of the plant. Sugarcane variety Ps. 92-1 (V_2) has better vegetative growth than sugarcane variety BM 13579 (V_1) and variety Ps. 89-1 (V_3) do, even when they are planted on different altitudes.

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