Response of the growth superior sugarcane clones on soil acidity levels sourced from budchip seeds

S Uchtiawati1*, S Budi1, Y Arifani1, and A E Prihatiningrum2

1 Faculty of Agriculture, University of Muhammadiyah Gresik, Indonesia
2 Faculty of Agriculture, University of Muhammadiyah Sidoarjo, Indonesia

* sri.uchtiawati@gmail.com

Abstract. Low productivity of sugarcane crop effects directly to sugar production. The low sugar production makes price principal sales become high. As a result, farmers income becomes low. One of causing low productivity is the variety of sugarcane crop which is planted has not good quality. One of efforts to increase sugarcane productivity is by producing superior sugarcane variety by doing crossing. This research cooperates with PG Gempol krep produced some sugarcane clones including SB1, SB2, SB3, SB4 and P3. The objective of this research is examining growth response of some sugarcane clones on soil acidity levels sourced from budchips seeds. This research used random complete group design which consist of two factorials and repeated three times. The first factor is sugarcane clones consist of SB1, SB2, SB3, SB4, P3 and BL as the control. The second factor is soil acidity levels consist of soil with pH 4.5, pH 7 and pH 8.2. The growth indicators of plant which observed include plant height, number of leaves, and number of tiller. The result showed that there is significant interaction of treatment sugarcane clones sourced from budchips seeds on variables number of tillers. The treatment of soil acidity levels showed significant interaction on the growth of sugarcane clones sourced from budchips seeds. There is no significant interaction between treatment sugarcane clones and soil acidity levels on sugarcane growth which planted from budchips seeds.

1. Introduction

The increase in population growth accompanied by the economic development of the people indirectly has an impact on increasing amount of national sugar consumption. However, the current problem is that increasing consumption of sugar cannot be offset by sugar production. It was proven that national sugar production in 2016 reached 2.2 million tons, while national sugar demand reached 5.7 million tons (industrial demand of 2.9 million tons and public consumption of 2.8 million tons). The low sugar production can be caused by the low productivity of sugar cane which tends to decline from year to year [1].

The low sugar production makes price principal sales become high. As a result, farmers’ income becomes low. Technically, the vulnerability of decreasing sugarcane productivity is closely related to land use systems, soil properties and sugarcane varieties. Therefore, it is necessary to increase and develop superior clones to produce high productivity. Indrawanto et al. stated that one of the factors that resulted in the low production of the national sugar industry was the condition of sugarcane varieties used showed the composition of maturity was not balanced between the initial mature, middle mature and final mature [2]. This is causing a prolonged milling period and many number of ripe sugarcane plants is cutting down and processing at an early stage so that the yield becomes low. Efforts to overcome
these problems can be done by using sugarcane seeds \((Saccharum \text{ sp.})\) from varieties that have the best growth. Acceleration the use of sugarcane superior seeds with budchip nurseries continues to be encouraged.

Rokhman et al. reported that the use of mule, budsheet and budchips did not show significant differences in the number of tillers formed at the end of the observation \([3]\). This condition shows that sugar cane plants derived from budchips can grow normally such as budsheet and mule nursery methods. Budchip sugarcane seeds have several advantages over conventional. The main advantage of using single bud (budchips) is the number tillers which emerge is much more because single bud (budchips) which have been moved to the field able to produce tillers for about 10-20 \([1]\).

Plant growth is determined by the nutrients needed. According to Wijaya the availability of nutrients in growing media is influenced by pH \([4]\). If the pH is too high or too low some elements settle, so that the roots cannot be absorbed and as a result the plant experiences deficiencies of related nutrients. Supplies that do not meet the needs of one or more elements can inhibit growth, reduce yield and reduce resistance to plant pests. Hardjowigeno and Sarwono explained that at the pH between 7-8, available elements for plants are Mg, K, Mo \([5]\). Based on this, it is necessary to test the growth of new sugarcane clones as result of crossing sourced from budchip sugarcane seeds at the soil acidity level to get the best results. So, that is why, the purpose of this study is to examine the growth response of some superior sugarcane clones (sourced from budchips seeds) on soil acidity levels (acidic, neutral and alkaline).

2. Methods

2.1. Time and place
The study was conducted in October 2017 to June 2018. The research was conducted at the Sugarcane Research and Development Center, Sugarcane Factory of Gempol Krep, Perning Village, Mojokerto Regency, Indonesia.

2.2. Materials and tools
Tools used in this study are hoes, crowbars, rulers, oven scales and drill. Then, materials used are potray, pots of size 35 cm, Nematicide, Plant Growth Regulator, Hot Water Treatment, fertilizer, acidic soil, neutral soil, alkaline soil, sugarcane seeds of SB1, SB2, SB3, SB4, P3, Bululawang/BL (control) and tag name.

2.3. Experiment design
This study consists of two factors; these are Sugarcane Clones and Soil Acidity Levels. Sugarcane Clones consist of Clone SB1, SB2, SB3, SB4, P3 and BL as control. Then, soil acidity level consists of soil with pH 4.5 (Acid Soil), soil with pH 7.2 (Neutral Soil) and soil with pH 4.5 (Alkaline Soil). So, the total of treatment combination was 18. The design of experiment used Factorial Group Random Design and each treatment repeated for three times. So there were 54 units of experiment.

2.4. Steps
First step was analyzing the soil. Here, sample of each soil was bought from some different places and then each of them will be analyzed based on the pH score and Aluminum content. Second, Producing Sugarcane Seeds in the form of Budchips Seeds. Here, Budchips seeds that used were clone of SB1, SB2, SB3, SB4, P3 and BL. Then, each of Budchips seeds boiled into hot water 60 L using Hot Water Treatment for about 20 minutes. Third, sterilize nursery media the nursery of media by frying the soils (nursery media) in a drum for about 30 minutes. Fourth, Planting the budchip seeds into Potray. Here, budchip seedling maintenance includes watering needed, fertilization, manual weed control once a week, pest and disease control. Budchips seedlings were fertilized with inorganic fertilizer with a dose of 2 grains per pot as much as 2 times during nursery at the age of 4 weeks and 8 weeks. Pest and disease control was carried out by using appropriate pesticides. Fifth, preparing the growing media which consist of three kinds of soil with different pH (Acid, neutral and Alkaline soil). Sixth, Transplanting budchips
seeds into the Pot. Seedlings are transferred to pots that have been filled with soil according to the treatment, then given the label and separator lines according to treatment. Each pot contains one plant seed. The pot that has been filled with seeds is watered sufficiently. Seventh, observe some growth indicators which consist of plant height, number of leaves and number of tillers. Then, the last was analyzing the data using ANOVA.

3. Results and discussions

3.1. Plant height

Table 1. ANOVA analysis result about the effect of sugarcane clones and soil acidity level to the height of sugarcane plant.

| Source       | DB | F Tables | 5  | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  |
|--------------|----|----------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Group        | 2  | 3.28     | 1.88| 1.72| 2.05| 2.36| 1.28| 3.33*| 4.1*| 4.23*| 4.96*| 4.97*|
| Clone        | 5  | 2.49     | 2.11| 1.92| 1.64| 1.44| 0.86| 1.1  | 1.31| 1.4  | 1.15 | 1.12 |
| Soil         | 2  | 3.28     | 3.16| 2.81| 2.51| 5.14*| 3.79*|2.9  | 1.5  | 0.95 | 0.3  | 0.31 |
| Clone X Soil | 10 | 2.12     | 0.81| 1.15| 0.7 | 1.03| 1.43| 0.96 | 0.8  | 1.08 | 1.1  | 1.12 |

Note: *) F-test 0.01 showed significantly difference
** *) F-test 0.05 showed strong significantly difference

Table 1 showed that there is no significant interaction between treatment combination of sugarcane clones and soil acidity level. It means that the sugarcane clone gives the same response to the soil acidity level. Soil acidity level has a significant effect on plant height at 8 and 9 weeks after moving to the growing media.

The results of this study indicated that there is no interaction between sugarcane clones with soil acidity level. This showed that the characteristics of parent genes from the crossing clones have the ability for adapting to a variety of soil acidity level (alkaline, neutral and acidic). It was because plant height is influenced by the nature of genes from the parents and also environmental factors.

This study also showed that the treatment of sugarcane clones had no significant effect to plant height. Meanwhile, treatment of soil acidity level was significantly affected to plant height. This is because soil acidity level (pH) affects soil nutrients such as Nitrogen (N), Potassium (K), and Phosphor (P) where plants need a certain amount to grow and develop. When the pH of soil is less than 5.5, it can cause the roots of the plant can not absorb water, while when soil pH above 7, sugarcane plant will be often lack the element of Phosphor [6]. In soil pH 8.2, there is a shortage of Cu elements causing the element of Fe accumulated in the segment, so that the sugarcane stems become short [7]. Moreover, Lakitan explained that if the availability of essential nutrients is less than the amount needed, the plant will be disturbed by its metabolism which can visually be seen from deviations in its growth [8].

Nutrients affect cell division. Increased cell division increases the number of cells more. Increasing the number of cells allows an increase in photosynthesis which can affect to plant height. Wijaya also added that the real effect of nutrient deficiency is inhibiting plant growth, so that the plant size becomes relatively smaller [4].
3.2. Number of leaves

Table 2. ANOVA analysis result about the effect of sugarcane clones and soil acidity level to number of leaves.

| Source | DB | F Tables | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|--------|----|----------|---|---|---|---|---|----|----|----|----|----|
| Group  | 2  | 3.28     | 4.68*| 4.32*| 7.05*| 1.25| 1.18| 4.36*| 5* | 3.9*| 0.2 | 0.03|
| Clone  | 5  | 2.49     | 0.63 | 0.57 | 1.37 | 1.23| 0.75| 0.64 | 1.33| 1.13| 1.94| 1.61|
| Soil   | 2  | 3.28     | 2.12 | 1.06 | 1.75 | 5.2*| 1.76| 2.26 | 1.12| 0.94| 1.58| 0.85|
| Clone  | 10 | 2.12     | 0.48 | 0.97 | 0.59 | 0.74| 1.71| 1.51 | 0.53| 0.71| 1.03| 0.82|

Table 2 showed that there is no significant interaction on treatment combination of sugarcane clones and soil acidity level. This showed that the clones have the same response as superior varieties of BL. Clone as control. Bululawang has plant characteristic which is having a good response if planted on neutral, acidic and alkaline soils. Ramadhan et al. stated that Bululawang can adapt widely to Ultisol, Vertisol, and Inceptisol soils [9].

The treatment of sugarcane clones also did not show a significant effect on the variable number of leaves. The treatment of soil acidity level has a significant effect on the number of leaves at the age of 8 weeks after planting. This study showed that the smallest number of leaves gained by sugarcane planted in alkaline soil. This condition is caused by leaves on alkaline soil experiencing a lack of Manganese (Mn) elements, so that young leaves experience chlorosis and have yellow color. Rosmarkam and Yuwono added that the element Zinc (Zn) in alkaline soils experienced a deficiency which caused the bone of leaves got chlorosis [7].

3.3. Number of tillers

Table 3. ANOVA analysis result about the effect of sugarcane clones and soil acidity level to number of tillers.

| Source | DB | F Tables | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|--------|----|----------|---|---|---|---|---|----|----|----|----|----|
| Group  | 2  | 3.28     | 0.77 | 3.7 | 3.18 | 2.48| 3.09| 5.84*| 5.99*| 4.64*| 3.13|
| Clone  | 5  | 2.49     | 3.50*| 2.78 | 1.5  | 1.52| 1.38| 1.51 | 1.08| 1.59| 0.78|
| Soil   | 2  | 3.28     | 6.79*| 5.35*| 11.80*| 9.06*| 12.25*| 11.62*| 8.12*| 3.17| 1.13|
| Clone  | 10 | 2.12     | 0.78 | 1.08 | 0.92 | 1.64| 0.85| 2.27 | 2.01| 1.94| 1.04|

Table 10 showed that sugarcane clones able to provide an equally good response to BL varieties (control) for the number of tillers. Based on the results of variance, the soil acidity level treatment had a significant effect on the number of tillers at 6, 7, 8, 9, 10, 11 and 12 weeks after planting. The treatment of sugarcane clones significantly affected the number of sugarcane tillers at the age 6 weeks after planting. The highest average number of tillers (13.52) was found in P3 clones and is significantly different from BL, SB1, SB2, SB3, SB4. It is suspected that the P3 clone still carries its genetic traits that are capable of creating many tillers.

4. Conclusion

This study has been carried out to examine the growth response of some superior sugarcane clones (sourced from budchips seeds) on soil acidity levels (acidic, neutral and alkaline). This study showed that there was no significant interaction treatment combination between sugarcane clones and soil acidity levels. This implied that sugarcane clones, these are SB1, SB2, SB3, SB4 and P3 clone provide.
the same good response compared to the control that is BL clone. Those clones have ability to adapt on soil acidity levels (acidic, neutral and alkaline). Treatment of Sugarcane clones from bud chips seed showed significant effect only on variable number of tillers at the age of 6 weeks after planting. Treatment of soil acidity level significantly affected to all variable of sugarcane growth which observed (plant height, number of leaves and number of tillers). It means that, The soil acidity level affects to the growth of sugarcane. This is because soil pH affects soil nutrients such as Nitrogen (N), Potassium (K), and Pospor (P) which needed by planted to grow and develop.

Acknowledgement

Thankful expressions are delivered to the Director General of Higher Education Ministry of Research, Technology and Higher Education of the Republic of Indonesia, Rector of University of Muhammadiyah Gresik and the managements of PTPN X Sugar Factory Gempolkrep especially to all budget support and facilities provided during the study.

References

[1] Budi S 2016 Test of Type Varieties and Hierarchical Arrangement Level of Nurseries Toward The Growth of Sugarcane (Saccharum Officinarum L.) Seed From Single bud International Journal of Applied Environmental Sciences 11(2) 441-455
[2] Indrawanto C, Purwono, Siswanto, Syakir M, and Rumini W 2010 Cultivation and Post Harvest of Sugarcane (Jakarta: ESKA Media)
[3] Rokhman H, Taryono and Supriyanta 2014 Number of Tillers and Yields of Six Clones of Sugarcane (Saccharum Officinarum L.) from Mule Seeds, Single Segment Eyes and Bud Bud Shoot Vegetalika 89-96
[4] Wijaya K 2008 Plant Nutrition As Result Quality Determinants and Plant Natural Resistance (Jakarta: Achievement Reader)
[5] Hardjowigeno H and Sarwono 2002 Soil Science (Jakarta: Akademik Pressindo)
[6] Leovici H, Kastono D, and Putra E T 2014 The Influence of Types and Concentrations of Organic Matter Sources of Natural Growth Regulators on the Early Growth of Sugarcane (Saccharum sp.) Vegetalika 22-34
[7] Rosmarkam A and Yuwono N W 2002 Soil Fertility Science (Jakarta: Kanisius)
[8] Lakitan B 2004 Basics of Plant Physiology (Jakarta: PT. Raja Grafindo)
[9] Ramadhan I C, Taryono R, and Wulandari 2014 Performance of Growth and Deposition of Five Cane (Saccharum Officinarum L) Clones in Ultisol, Vertisol and Inceotisol Vegetalika 77-87