Application of humic acid and guano on sugarcane seedlings with bud set propagation method

A Mollah, H Iswoyo, and N Reskiana
Department of Agronomy, Universitas Hasanuddin, Jl. Perintis Kemerdekaan KM.10 Makassar, Indonesia
Email: mollah_jaya@yahoo.com

Abstract. This study aims to determine the effect of humic acid and guano obtained from swallow bird on the growth of sugarcane seedlings propagated with bud set method. The research was carried out in the form of a two-factor factorial design with a randomized block design (RBD) as an environmental design. Humic acid as the first factor consisting of 3 levels, namely: 0% (v/v) mL per polybag, 5% (v/v) mL per polybag, and 10% (v/v) mL per polybag and Swallow guano as the second factor consists of 4 levels, namely: 0 g per polybag, 150 g per polybag, 300 g per polybag and 450 g per polybag. The results showed that the treatment of humic acid application with a concentration of 10% (v/v) mL per polybag tended to give the best results on the highest leaf number parameter 9.50 strands and the application of guano fertilizer at a dose of 300 g per polybag tended to give the best results on parameters of plant height (54.55 cm). There is an interaction between the application of humic acid application dose of 10% (v/v) mL with guano fertilizer dosage of 150 g per polybag. This combination gave the best results on the number of leaves (9.50). Humic acid with a concentration of 10% (v/v) mL per polybag showed the best results on the parameters of plant height, number of leaves, number of saplings. While application of guano fertilizer at a dose of 300 g per polybag showed the best results on plant height parameters, cane diameter, number of saplings.

1. Introduction
As a main sugar producing plant, sugarcane (Saccharum officinarum L.) has emerged as an important strategic commodity for the people and government of Indonesia for its high economic value, and high demand material for the food or beverage industry. Market demand for national sugar consumption needs increases along with the the population, while the domestic sugarcane production has not been able to meet domestic consumption. Thus, sugar is one of imported commodity to meet the national needs [1].

In order to reduce the import, the Indonesian government conducted a sugar self-sufficiency program that has set a production target of 5.7 million tons of sugar in 2014 to overcome the sugar insufficiency. However, this program has not yet reached the specified target due to several constraints including the limited area of sugar cane plantations, low productivity, cultivation techniques, and low sugar yield [2].

Efforts to increase the production and productivity of sugarcane have been carried out through the National Sugar Productivity Acceleration Program since 2004 through the replacement of aged plants with superior seedlings. Planting using buds has not been widely applied in farmers, and the arrangement of varieties will have an impact on the needs of large numbers of seedlings [3].
Nursery with mule seedlings cannot meet the needs of sugarcane plants in large numbers due to high growth failure occurrence. Preparation of seedlings by conventional methods (mules) is significantly affected nursery management because it takes 6 months for one planting period. In addition to the preparation of seedlings, the quality of the seedlings is one of the factors that is crucial for the success of sugarcane cultivation [4].

Understanding these problems, it is essential to have technology that can help time efficiency in nurseries, cost-effective, does not require a large space and capable to produce quality seedlings. Nursery with bud set propagation method is one solution in developing superior seedlings. Seedling of a single segment (bud set) is the technology of accelerating sugarcane seedlings originating from stems of approximately 10 cm in length consisting of one healthy bud and located in the middle of two segments [5].

The method of cutting mules for bud sets can be done manually either by sawing or by mechanical means with cutting machines. The purpose of using this budset method are: a. to save nursery space, b. to produce seedlings with uniform growth in the field, c. to produce large number of seedlings.

2. Humic acid and guano application

One alternative in the application of agricultural biotechnology is by utilizing humic acid and fertilizer derived from guano of swallows. Humic acid is a decomposition of organic matter that can improve soil structure [6]. Meanwhile, guano swallow fertilizer is an organic fertilizer that has nutrients such as Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sulfur and Potassium which can support growth, strengthen plant stems, optimize photosynthesis processes, optimize the growth of new leaves and stimulate root strength [7].

Humic acid is an organic compound that is relatively resistant, colloidal, derived from the decomposition of organic matter, solution in bases and settles in acid. The application of humic acid can directly and indirectly affect plant growth. The effect of humic acid indirectly through improved soil properties, so that nutrient uptake by plants increases, eventually plant growth also increases. While the direct effect is through improved metabolic processes in plants, such as increased root respiration, protein synthesis, nucleic acids [8], and an increase in the rate of photosynthesis [9].

The addition of swallow guano serves to improve and enrich the soil structure because it contains 40% of organic material, there are microorganisms that are beneficial for plant growth and as a natural fungicide, have good cation exchange capacity (CEC) so that plants easily absorb beneficial elements in fertilizer. Swallow guano are slow to dissolve or release nutrients slowly so that the time interval is intended to ensure the availability of adequate nutrients when needed. As a result, the availability of nutrients can synergize with age and plant growth [7].

The use of humic acid and swallow guano is one effort to maintain the sustainability of the land, as a nutrient to overcome the problem of macro and micro nutrient deficiencies in plantations, improve soil quality and health (soil remediator), as well as practical and environmentally friendly applications.

3. Methodology

An experiment has been conducted in the form of a factorial experiment using a Factorial 2 Factor Design with Randomized Group Design as an environmental design. This study consisted of 2 factors: the first factor was humic acid with 3 levels, namely without humic acid (h0), humic acid 5% v/v (h1), and humic acid 10% v/v (h2). The second factor is the application of guano swallow fertilizer with 4 levels, namely without swallow fertilizer (w0), swallow fertilizer 100 g (w1), swallow fertilizer 200 g (w2), swallow fertilizer 300 g (w3).

3.1. Nursery media and seedling preparation

Growing media used in the nursery is beds that have been composted.
The tool used for cutting the seeds is a hacksaw. The source of propagated cane was sugar cane which is 6-8 months old. Seedlings taken in the form of one bud with the eye position is located in the middle of the length of the cuttings.

3.2. Treatment (Hot Water Treatment).
After the seedlings cutting, these seedlings will be treated with Hot Water Treatment (HWT) using water at a temperature of 50 °C for 15 minutes. After cooling, the buds that have been treated (HWT), then immersed again using the composition of the Cruiser 350 ps insecticide solution dose of 12.5 ml/40 liters of water, fungicide Dethane M-45 Dosage 10g/40 liters of water, and substances growth stimulants atonic 10 ml / 40 liters of water for 15 minutes.

3.3. Planting
After the hot water treatment and soaking in the solution is complete, the seedlings were drained, then sorted to remove seedlings with eyeshoot damage. Then sowing on beds that have been applied with compost, with the position of the buds up. The soil used to cover the bud set should be a thin layer i.e. about 1 cm, the seedlings are sown for 14 days.

3.4. Seedlings transfer and arrangement
After 14 days, the seedlings were marked by the release of 5-10 cm shoots or the leaf buds (1-2 strands) begin to open, the seeds were then transferred to a polybag containing soil media (2:1 soil, compost) that has been sterilized. The sugar cane seedlings were then arranged according to a predetermined experimental design in the screen house.

3.5. Treatment application and seedling maintenance
Humic acid was applied twice and the guano was applied once at the beginning of the planting. All treatment of humic acid application for each polybag is 100 mL. humic acid dilution of 5% is the addition of water as much as 100 mL to 5 mL of humic acid, while for the solution of 10% humic acid is by adding water as much as 100 mL to 10 mL of humic acid. Application was performed after seedlings transfer at the age of 2 weeks and at the age of 4 weeks.

Application of guano fertilizer was at the beginning of planting according to the treatment dose. Application was carried out immediately before the seedlings transfer. The guano fertilizer was well mixed with soil and compost. Maintenance was performed by watering every day, to keep the seedlings not too wet and not too dry. Weeding was performed as necessary as well as pests and diseases control.

4. Results

4.1. Plant Height (cm)
The results of measurements and variations in plant height at 12 weeks after planting (WAP) showed that the treatment of guano fertilizer (w) has a very significant effect on plant height while the application of humic acid (h) doses and interactions has no effect on the plant height.

| Humic acid | w0 | w1 | w2 | w3 |
|------------|----|----|----|----|
| h0         | 49.22 | 48.23 | 52.37 | 44.83 |
| h1         | 42.57 | 54.25 | 54.98 | 43.48 |
| h2         | 48.50 | 48.55 | 56.30 | 39.78 |
| Average    | 46.76bc | 50.34ab | 54.55a | 42.70c |
Numbers followed by different letters in the line (a,b) were significantly different at the level of 95% (Tukey’s p≤=0.05).

Table 1 shows that guano fertilizer at a dose of 300 g per polybag (w2) produced the highest average plant height of 54.55 cm, not significantly different from the treatment dose of 150 g per polybag (w1) but significantly different from the control treatment (w0) and the treatment dose of 450 g per polybag (w3) which produced the lowest average plant height of 42.70 cm.

4.2. Number of leaves (strands)
The treatment of humic acid (h) and guano fertilizer (w) did not significantly affect the number of leaves but there were interactions on both factors on the number of leaves.

Table 2. The average number of leaves (strands) of sugarcane seedlings from Bud set with various doses of humic acid and guano swallow fertilizer at 12 weeks after planting (MST).

| Humic acid | Swallow guano fertilizer | LSD h |
|------------|--------------------------|-------|
| h0         | w0                        | 7.67b |
|            | w1                        | 8.67b |
|            | w0                        | 9.17a |
|            | w3                        | 8.50b |
| h1         | 9.00a x                   |       |
|            | 8.17b y                   |       |
|            | 9.17a x                   |       |
|            | 9.33a x                   | 0.55  |
| h2         | 9.33a x                   |       |
|            | 9.50b x                   |       |
|            | 8.50b y                   |       |
|            | 8.33b y                   |       |
| LSD w      |                          | 0.59  |

Numbers followed by different letters in the line (a,b) and column (x,y,z) were significantly different at the level of 95% (Tukey’s p≤=0.05)

Table 2 shows that the treatment of 10% (v/v) mL humic acid and guano fertilizer at a dose of 150 g per polybag (h2w1) produced the highest average number of leaves at 9.50 strands. There was no significant difference in the treatment of 10% (v/v) mL humic acid without guano (h2w0) but it was significantly different in the treatment of 10% (v/v) mL humic acid and guano fertilizer at a dose of 300 g per polybag (h2w2) and humic acid treatment at a dose of 10% (v/v) mL and guano fertilizer at a dose of 450 g per polybag (h2w3). The treatment of humic acid dose of 10% (v/v) mL and guano at a dose of 150 g per polybag (h2w1) was significantly different from unit without humic acid and guano fertilizer at a dose of 150 g per polybag (h0w1) as well as humic acid treatment at a dose 5% (v/v) mL and guano fertilizer at a dose of 150 g per polybag (h1w1).

The treatment without humic acid and guano swallow fertilizer (h0w0) which produced the lowest average number of leaves was 7.67 strands significantly different from the treatment without humic acid and guano swallow fertilizer at a dose of 300 g per polybag (h0w2), treatment without humic acid and guano fertilizer at a dose of 150 g per polybag (h0w1), treatment without humic acid and guano fertilizer at a dose of 450 g per polybag (h0w3). The treatment without humic acid and guano (h0w0) was significantly different from the humic acid treatment of 5% (v/v) mL and without guano (h1w0) and the humic acid treatment of 10% (v/v) mL without guano fertilizer (h2w0).

4.3. Cane Diameter (mm)
The average diameter of the cane of the seedlings bud set with various doses of humic acid and guano fertilizer at 12 weeks after planting (MST) is shown in Figure 1.
Figure 1. Average diameter of the sugar cane seedlings from bud set at 12 weeks after planting

Figure 1 shows that the highest average cane diameter at the age of 12 WAP was in the treatment without humic acid with guano fertilizer of 300 g per polybag (h0w2), which was 30.25 mm while the lowest cane diameter was found in the treatment without humic acid and guano fertilizer of 450 g per polybag (h0w3) which was 19.52 mm.

4.4. Number of saplings
The treatment of guano fertilizer (w), humic acid (h) and interactions have no significant effect on the number of saplings. The average number of cane seedlings produced by Bud set with various doses of humic acid and guano fertilizer at 12 weeks after planting is presented in Figure 2.

Figure 2 shows that the highest average number of saplings at 12 WAP was 10% (v/v) mL of humic acid combined with 300 g of guano fertilizer (h2w2), i.e. 2.40. While the lowest number of saplings was found in the unit without humic acid and without guano fertilizer (h0w0), which was 1.95.

5. Discussion
5.1. Effect of Humic Acid
The results of variance showed that administration of humic acid had no significant effect on all parameters observed. This happens because the response of humic acid biofertilizers is slowly available to plants. Therefore, plants have not given a significant effect and the microorganisms
present in humic acid cannot be symbiotic properly in the soil causing a lack of treatment effect on plant growth. This is appropriate, according to Damanik, Hasibuan, Fauzi, & Hanum [10] which states the difference between biological fertilizers and chemical fertilizers is the response of slow plants, the supply of indirect nutrients, therefore plants have not given a response that has a significant effect. And the content that is in biological fertilizer is less influential on growth because it can be washed away due to extreme weather.

Other contributing factors are the availability of organic material present in the soil that is used as a planting medium and the soil which will be available and absorbed by plant roots to be transplanted to the active parts of plants that are not yet optimal. This is in accordance with the research of Bandu [11], stating that the levels of organic matter in the study location are different. However, research on organic matter content conducted in the experiment site revealed the highest organic matter content, reaching 1.60% while the lowest organic matter content is 0.26%. The higher the content of organic matter in a land, the more fertile the land, whereas the less organic matter the soil is less fertile. The role of organic matter is very large because it can increase the ability of the soil to retain nutrients in the sense that the capacity of the soil cation becomes higher and as a source of energy for living organisms. Soil organic matter also influences the growth of a plant to achieve maximum growth. However, as seen in table 2 for the number of leaves the dose of 10% (v/v) mL has the highest average number of leaves i.e. 9.50 strands. This is in accordance with research conducted by Khotimah [12], that the treatment of humic acid application of 10% (v/v) per polybag produced the highest average number of leaves. According to Minardi, Suntoro, & Handayanto [13], the potential use of humic acid has an influence to stimulate plant growth. Gardiner & Miller (2004) also stated that compounds which affect plant growth in humic acid are very much like vitamins, amino acids, auxin and IAA.

According to Ihdaryanti [15], auxin application to plants increases the permeability of cell walls which will enhance the absorption of nutrients, namely the elements N, Mg, Fe and Cu to form chlorophyll which is needed to enhance photosynthesis. With increased photosynthesis results and together with auxin move towards the roots which will stimulate the formation of gibberilin and cytokinins in the roots and transported to the plant canopy. Increasing gibberiline and cytokinins in plant canopy will increase the number of cells and cell size along with increased photosynthate yields at the beginning of planting will accelerate the process of vegetative growth.

5.2. Effect of Guano Fertilizer
The results of variance indicate that the administration of guano swallow fertilizer has a very significant effect on plant height starting at 12 WAP. Guano fertilizer had no significant effect on the parameters of the number of leaves, cane diameter and number of saplings. The results showed that the highest average height of sugar cane plants at the age of 12 WAP was a dose of 300 g of guano fertilizer (w2) which was 54.55 cm significantly different from other dose of guano. This is in accordance with research conducted by Talino, Zulfita, & Surachman [16] that the administration of swallow droppings as much as 309 g per plant or equivalent to 10% of organic matter produces the highest mung bean plants. Plant height is a result of increased cell division and enlargement from plant photosynthesis. Photosynthetic results during the vegetative growth phase are transplanted to the stem so as to increase plant height. The increase in plant height is also influenced by various factors such as physical and chemical properties of the soil including the availability of nutrients. In addition, according to Harjadi [17], yield components also indicate the higher the dose of organic fertilizer given, the higher the yield component produced.

Application of guano fertilizer showed similar effect on the parameters of number of leaves, cane diameter and number of tillers. This could be influenced by genetic factors of sugarcane. Besides that it is also influenced by environmental factors of plant growth and development. The most influential factors on plant growth are temperature, humidity and rainfall. According to Harjadi [18], the rate of transpiration is influenced by environmental factors, namely temperature and humidity of the air. If the
temperature is high then the humidity will be low, causing the transpiration rate to decrease, and vice versa. Inhibiting the rate of transpiration causes plants to absorb water from the soil to compensate for high evaporation. Thus will increase the absorption of nutrients from the soil for the purposes of photosynthesis.

5.3. Interaction of both treatments
The results showed that the combination of humic acid treatment and guano fertilizer only significantly affected the number of leaves at 12 WAP. The combined treatment of 10% (v/v) mL of humic acid and 150 g of guano fertilizer (h2w1), produced a better number of leaves with an average of 9.50 strands. One nutrient that can be increased when giving humic acid is nitrogen. Nitrogen is one of the elements that has an immediate effect on plants. The main role of this element is to stimulate vegetative growth and increase the number of tillers [19]. In addition to nitrogen, humic acid also contains a compound that is as a stimulant of plant growth, in the form of organic compounds that can support the physiology of plants, [20]. Furthermore according to Gardiner & Miller (2004), compounds that trigger plant growth in humic acid are very numerous, such as vitamins, amino acids, auxin, and Indole Acetic Acids (IAA). According to Talino et al. [16], swallow droppings contain a lot of organic matter that can add plant nutrients.

Almost all parameters did not interact or significantly affected the combination of humic acid treatment and guano fertilizer. This could relate to many factors that affect the growth and yield of sugarcane, these factors such as genetic and environmental conditions. According to Lingga and Gusmiaty [21][22] that the response of fertilizers to plants is largely determined by various factors, including the genetic characteristics of plants, climate, soil, where these factors do not stand alone but one factor is related to other factors.

Of the several parameters only one parameter showed significant interaction of both treatments. It also presumably because the two treatments were not able to work optimally to interact with each other to support the relatively short growth period in the sugarcane nurseries. According to Hanafiah [23] no interaction between two treatment factors can indicate that the two factors are not able to work together because the mechanism of action is different one another, or one of the factors does not play an optimal role or even antagonistic to the other, so that they suppress each other's influence. Also it could be due to the same role in increasing plant growth and yield by the two factors.

6. Conclusion
There was no real effect on the application of humic acid which gives the best effect on the growth of sugarcane. However, the treatment of humic acid application with a concentration of 10% (v/v) mL per plant tended to give the best results on the leaf number parameter i.e. 9.5 strands. Application of guano fertilizer at a dose of 300 g per plant provided better growth with plant height parameters at the age of 12 week after planting which was 54.55 cm.

There is an interaction between the treatment of humic acid dose of 10% (v/v) mL per plant and the dose of guano fertilizer of 150 g per plant which gave the best number of leaves. However, no interaction for the rest of parameters

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