ABSTRACT

The aim of this research was to compare the effect of substitution of Ammonium Sulphate (AS) fertilizer on sugarcane growth, nutrient content, and soil chemical properties. This research was conducted on up-land of sugarcane plantation in Tegalweru village, Dau district, Malang regency. This study tested ten treatments consisting of three treatments using AS fertilizer, six treatments using AS substitute fertilizers that used combination of Urea, Gypsum, and bio-compost and one control (no fertilizer). This research used randomized complete block design with three replications. The results showed that the plant growth between the treatment used AS fertilizer and AS substitute was not significantly different. However, the treatment used 400 kg Urea per ha+938 kg Gypsum per ha tended to have the best plant growth and the highest N uptake. For the treatments using AS substitute fertilizer, the higher the application rate was, the higher the soil N and S contents were. The treatments used AS fertilizer due to lower soil pH than AS substitute fertilizer. Based on this research, it can be concluded that the use of alternative fertilizers as a substitute of the AS fertilizer is recommended to reduce an adverse impact on soil fertility.

Keywords: AS fertilizer, AS substitute fertilizer, sugarcane, nutrient content, soil chemical properties

INTRODUCTION

The Ammonium Sulphate (AS) fertilizer is a source of N fertilizer widely used by farmers. In addition, AS fertilizer also contains sulfur which can increase the production of sugarcane and sugar content. Application of AS fertilizer in sugarcane cultivation has been proven to be able to increase the sugarcane yield up to the optimum dose of 500-800 kg per ha (Usman and Sumoyo, 1991; Lestari, 1993; Windiharto, 1994; Anonymous, 2007). Simoen (1995) reported that the application of excessive N fertilizer would reduce the quality of the sugarcane as raw materials of sugar manufacturer, due to the decrease in the amount of productive stems and the increase in the diameter of unproductive stem. In line with the statement of the center of sugarcane research LSUAg Centre Iberia, the decreasing of the sugar yield can occur when the use of N more than 150-180 kg N per ha (Anonymous, 2007, www.LSUAgCentre.com., Accessed 17 February, 2007).

In fact, many cane growers in Malang, East Java applied AS fertilizer in excess of recommended rates by 1-2 Mg/ha. The negative impact of excessive application of N fertilizer can cause the nitrate pollution in groundwater (Guillard et al., 1995; Zhang et al., 1996; Stites and Kraft, 2001; Ramos et al., 2002) and eutrophication in the adjacent surface of water (Hattermink, 2005), the low efficiency of plant nutrient use (Zhu et al., 2005), soil salinity and acidification (Hattermink, 2003).

The major cause of soil acidification in the use of N fertilizers was the production of NH_{4}^{+} such as Ammonium Sulphate (AS) (Hartemink, 2003). All ammoniacal N fertilizers release protons when NH_{4}^{+} is oxidized to NO_{3}^{-} by nitrifying microorganisms. Mineralization of organic matter can contribute to soil acidity by the oxidation of N and S to HNO_{3} and H_{2}SO_{4} in a similar manner (Summer, 1997). The decrease in the soil pH

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affects the availability of the soil nutrients. It will cause a decline in soil fertility of sugarcane lands (Hattermink, 1998). Sulphate (SO$_4^{2-}$) ion accumulation of the overuse of AS fertilizer that is not absorbed by plants will be leached into the subsurface environment which has impact on groundwater (Havlin et al., 2005).

Pankhurst et al. (2003) concluded that in the short term, the application of inorganic fertilizers had direct impact on soil organisms, such as reducing the number and activity of soil microorganisms due to the increase in availability of mineral nutrients in the soil that could be toxic for soil microorganisms. Barry et al. (2001) reported that in the long term, the application of inorganic fertilizers can provide indirect effect to changes in soil pH, soil physical properties (porosity and aggregation), and changes in productivity, input-residue and soil organic C content. This negative impacts can be minimized if farmers want to use a substitute fertilizer that has the same nutrient with the AS fertilizer which is more environmentally friendly so that soil productivity can be maintained in the long term.

Seeing this phenomenon, the substitution of AS fertilizer was replaceable by another fertilizer that had the same function and role on the growth and yield of sugarcane, but more conducive environment was required. Several studies about substitution of AS fertilizer with another alternative fertilizer such as urea have been conducted in Indonesia or abroad. However, the results of research show that the AS fertilizer had a tendency to be better than urea, so it can be concluded that the AS fertilizer can’t be replaced by urea. In the studies of AS substitution, it seems that it only focused on finding the alternative sources of N fertilizer in addition to the AS (Simoen, 1995). The substitution of AS fertilizer that considered the S contain of AS fertilizer has not been studied. S nutrient has a significant role in increasing growth and yield of sugarcane. S is a secondary macro nutrients required in considerable amounts. Sulfur bring benefits to plants such as: (1) assisting the formation of grain so the leaves become greener, (2) adding protein and vitamin content of crops, (3) increasing the number of productive tillers (in rice), (4) playing an important role in the sucrose synthesis, (5) improving the color, flavor, and flexibility of tobacco leaves (especially on omprongan tobacco), (6) improving flavor, reducing shrinkage during storage, enlarging bulb onions and garlic (Anonymous, 2006).

Blair (1998) reported that sulfur activated several enzymes and some vitamins and production of oil glucosidal synthesis. Sulfur also plays an important role in photosynthesis through Ferrodoxin component involved as a reducing agent for reduction of nitrite. When sulfur deficiency occurred in plants, the stems become thin and weak. The sulfur-deficient plants showed symptoms as found in plants with nitrogen deficiency, such as reduction in the chlorophyll content (chlorosis), increasing starch and sucrose, and decreasing glucose levels leading to decreasing sweetness level of sugar cane. Sulfur deficiency is often seen in young yellowish green leaves unlike the case of N deficiency occurring in older leaves because nitrogen is a mobile nutrient, while sulfur is immobile in plant tissue (Korbs et al., 2005). Sugarcane can absorb sulfur as 25-40 kg ha$^{-1}$ for the plant cane and 14-28 kg S per ha for ratoon sugarcane (Usman, 1989). Total sulfur requirement may be fulfilled with the AS fertilizer 200 kg per ha.

Based on the information, this study of the application of N and S using fertilizer sources other than the AS fertilizer as an alternative fertilizer is necessary to be done in sugarcane cultivation. This study was initiated using commonly available fertilizer sources such as urea, gypsum and biocompost of solid waste of sugar mill to compare their effect on sugarcane growth, nutrient content, and soil chemical properties.

**MATERIALS AND METHODS**

A field experiment was conducted in sugarcane land from early March to November 2010, at Tegalweru village, Dau district, Malang regency with latitude 07°56.638 S, longitude 112°34.913 E, altitude 680 m above sea level and Inceptisol soil type. The soil characteristic was loam and consisted the following: 20% clay, 49% silt, and 31 % sand. The soil had bulk density of 1.23 g/cm$^3$. The soil was low in organic carbon (1.03 %), with pH 6.4, low in total N (0.14%), medium in phosphorus (32.37 mg per kg), low in available K (0.13 me/100 g soil). The experiment used randomized complete block design with three replications and ten treatments (Table 1).
Table 1. Treatments used in this study

| Treatments | N Doses (kg/ha) | S Doses (kg/ha) | AS Fertilizer (kg/ha) | Urea Fertilizer (kg/ha) | Biocompost (kg/ha) | Gypsum (kg/ha) |
|------------|----------------|----------------|-----------------------|------------------------|-------------------|---------------|
| T0         | -              | -              | -                     | -                      | -                 | -             |
| T1         | 100            | 120            | 500                   | -                      | -                 | -             |
| T2         | 140            | 168            | 700                   | -                      | -                 | -             |
| T3         | 180            | 216            | 900                   | -                      | -                 | -             |
| T4         | 100            | 120            | -                     | 223                    | -                 | 522           |
| T5         | 140            | 168            | -                     | 312                    | -                 | 730           |
| T6         | 180            | 216            | -                     | 400                    | -                 | 938           |
| T7         | 100            | 120            | -                     | 110                    | 1950              | 522           |
| T8         | 140            | 168            | -                     | 155                    | 2750              | 730           |
| T9         | 180            | 216            | -                     | 200                    | 3550              | 938           |

Remarks: S content in AS Fertilizer = 24%; N content in AS Fertilizer = 20%; S content in Gypsum = 19%; N content in Urea Fertilizer = 45%; N content in Biocompost = 2.57%. Gypsum is used as S fertilizer source and Ca content in Gypsum not calculated in the dose of the treatments.

As a substitute of AS fertilizer, Urea and Biocompost were used as sources of N, and gypsum was used as a source of S. SP-36 with a dose of 300 kg per ha and KCl with a dose of 200 kg per ha were applied as base fertilizers. Double-bud sugarcanes (variety BL-Red) were used as planting material. Each plot had an area 3 m x 4 m in which four rows of cane were planted at an inter-row spacing of 1 m and 0.5 m interplant spacing. Sugarcane stalks were buried in the prepared planting hole then covered with soil. Ammonium Sulphate (AS) and urea fertilizer were applied in two stages. The first stage was 50% of the dose given at two weeks after planting. The second stage was 50% of the dose given one month after the first application. Full amount of biocompost manure and gypsum were applied three days before planting. Full amount of SP-36 fertilizers were applied at planting time. Full amount of KCl fertilizer was applied at age of one month after planting. Biocompost and gypsum were applied in trenches and thoroughly mixed with soil. Growth variables consisting of height of stalks, stalk diameter, and number of tillers were counted monthly. Leaf samples from top of the plants were collected for analysis of N and S uptake at four months after planting. Soil samples for analysis soil chemical properties (soil pH, soil N content and soil S content) were collected at three months and seven months after planting. The N analysis used the Kjeldahl method, SO₄²⁻ content by turbidimetric method and the soil pH was determined in 1 : 2.5 soil water suspensions. (Okalebo and Gathua, 1993). Data were statistically analyzed by using analysis of variance (ANOVA) and the treatment differences were measured using Least Significant Difference (LSD) test at 5%.

RESULTS AND DISCUSSION

The Growth of Sugarcane

The analysis of variance (ANOVA) of growth variables from the age of one month to seven months showed that the tested treatments had significant effect on stalk height, number of stalks and diameter of stalks (Table 2-4). The result showed that the control treatment gave the lowest stalk height compared with treatments using fertilizer. In general, the treatments that used AS fertilizer were not significantly different (P>0.05) from the treatments using AS substitute fertilizer (Table 2). The treatments using AS substitute fertilizer tended to have a lower number of tiller on early growth than the treatments using AS fertilizer application at the highest dose. The stalk diameter was not significantly different (P>0.05) (Table 3). The treatments using AS substitute fertilizer (combination of urea + gypsum and urea + biocompost + gypsum) had higher average stem diameter than the those with AS fertilizer application at the highest dose. The stalk diameter was not significantly different (P>0.05) (Table 4). This might have been caused by the effect of gypsum that supplied the elements of S and Ca to the crops. Ca can strengthen the cell walls of plants so the plants do not easily collapse and...
improve soil structure so better root development and soil aeration are maintained with good oxygen diffusion from the atmosphere (Glass, 1998; Nerilde et al., 2008). In addition, gypsum does not have negative impacts on soil chemical properties because gypsum is neutral. If the condition of physical and chemical properties are good, plant growth and development will be better and the optimal yield can be achieved (Mohandas et al., 1993 and Viator et al., 2002).

The growth of sugarcane height was better in the treatment using the combination of urea + gypsum fertilizer compared with AS fertilizers. It suggests that the fertilizer was absorbed well by the sugarcane, while the AS fertilizer, which is easily soluble in the soil, was particularly vulnerable to loss through leaching process when the rain fell to the ground and moved to the sub-surface layer. So in the early growth of sugarcane, the roots of sugarcane could not absorb the N and S nutrient of the AS fertilizer. Meanwhile, the treatments of AS substitute fertilizer using biocompost released nutrient slowly in all of growth stages (Handayanto et al., 2004). So, in the initial growth, the sugarcane could not absorb optimally.

Table 2. Stalk height of plant cane as influenced by the treatment of AS fertilizer and its substitutes (urea, gypsum and biocompost) at various ages of sugarcane

| Treatments | Stalk height (cm) of sugarcane at various ages of sugarcane (month) |
|------------|---------------------------------------------------------------|
|            | 1     | 2       | 3       | 4       | 5       | 6       | 7       |
| T0         | 9.1 a | 21.6 a  | 62.8 a  | 83.3 a  | 109.7 a | 112.8 a | 121.7 a |
| T1         | 10.5 b| 29.2 cd | 70.1 b  | 110.9 bc| 127.4 b | 130.0 b | 132.3 b |
| T2         | 10.5 bc| 31.2 d | 73.2 bc | 112.7 bcd| 127.6 b | 129.5 b | 132.5 b |
| T3         | 10.6 bc| 30.2 d | 74.5 bcd| 114.1 cd| 131.4 b | 133.9 bcd| 136.3 cd|
| T4         | 10.2 a| 30.7 cd | 74.7 cd | 116.5 d | 132.3 bc | 135.3 cde| 138.3 cd|
| T5         | 10.8 bc| 31.0 d | 75.2 cd | 114.1 cd| 129.4 b | 132.1 bc | 134.8 bc|
| T6         | 11.7 bcd| 31.2 d | 76.6 d  | 116.7d  | 134.8 c | 138.2 e | 140.9 d |
| T7         | 11.8 cd| 24.8 b | 74.9 cd | 106.4 b | 128.2 b | 137.4 e | 138.7 cd|
| T8         | 11.5 bcd| 27.8 c | 76.2 d  | 112.9 bcd| 135.2 c | 137.1 d e| 139.7 cd|
| T9         | 12.4 d| 29.7 cd | 71.7 bc | 118.3 d | 129.0 b | 132.2 bcd| 136.2 bcd|

LSD at P= 5% | 1.2 | 2.3 | 3.5 | 5.8 | 5.3 | 4.9 | 5.1 |

Remarks: The numbers followed by the same letters within the same columns are not statistically significant at p<0.05.

Table 3. Number of tiller per row of sugarcane as influenced by the treatment of AS fertilizer and its substitutes (urea, gypsum and biocompost) at various ages of sugarcane

| Treatments | Stalks number of sugarcane at various ages of sugarcane (month) |
|------------|---------------------------------------------------------------|
|            | 1     | 2       | 3       | 4       | 5       | 6       | 7       |
| T0         | 11    | 16.2 a  | 20.6 a  | 22.9 a  | 18.3 a  | 18.3 a  | 18.3 a  |
| T1         | 11    | 21.8 b | 26.2 b  | 27.1 b  | 24.7 bcd| 24.7 b  | 24.7 b  |
| T2         | 11    | 22.9 bc| 27.3 b  | 28.7 b  | 25.3 bcde| 25.3 bcd| 25.4 b  |
| T3         | 11    | 24.4 bcd| 28.6 b  | 28.7 b  | 24.1 b  | 24.1 b  | 23.1 b  |
| T4         | 11    | 19.1 cd| 26.3 b  | 26.9 b  | 27.0 ef | 27.0 cd | 24.0 b  |
| T5         | 11    | 23.4 d | 26.6 b  | 28.2 b  | 27.8 f | 27.8 d  | 24.4 b  |
| T6         | 11    | 24.6 de| 27.5 b  | 28.2 b  | 26.2 cdef| 26.2 bcd| 24.5 b  |
| T7         | 11    | 19.6 de| 26.0 b  | 26.8 b  | 24.4 bc| 24.4 b  | 24.4 b  |
| T8         | 11    | 20.1 e | 26.8 b  | 27.9 b  | 26.0 cdef| 26.0 bcd| 24.9 b  |
| T9         | 11    | 21.4 e | 26.5 b  | 28.5 b  | 26.5 def| 26.5 bcd| 24.9 b  |

LSD at P= 5% | 0.0  | 2.2  | 2.3  | 2.0  | 1.9  | 2.5  | 2.7  |

Remarks: The numbers followed by the same letters within the same columns are not statistically significant at p<0.05.
Table 4. Stalk diameter of sugarcane as influenced by the treatment of AS fertilizer and its substitutes (urea, gypsum and bio-compost) at various ages of sugarcane

| Treatments | 1     | 2     | 3     | 4     | 5     | 6     | 7     |
|------------|-------|-------|-------|-------|-------|-------|-------|
| T0         | 0.76 a| 1.12 a| 2.65 a| 2.69 a| 2.74 a| 2.74 a| 2.81 a|
| T1         | 0.77 a| 1.38 b| 2.78 bcd| 2.79 abc| 2.90 bc| 2.90 bc| 3.08 de|
| T2         | 0.89 ab| 1.36 c| 2.73 abc| 2.79 abc| 2.85 b| 2.85 b| 2.90 b|
| T3         | 0.86 abc| 1.36 c| 2.80 cd| 2.84 bc| 2.94 bcd| 2.94 bc| 3.01 cd|
| T4         | 1.01 abc| 1.34 b| 2.80 cd| 2.76 ab| 2.94 bcd| 2.94 bc| 3.02 cde|
| T5         | 0.84 bc| 1.37 cd| 2.71 abc| 2.80 abc| 2.93 bcd| 2.93 bc| 3.04 cde|
| T6         | 0.99 ab| 1.49 c| 2.73 abcd| 2.91 c| 2.97 cd| 2.97 c| 3.11 e|
| T7         | 0.96 bc| 1.34 b| 2.69 ab| 2.76 ab| 2.90 cd| 2.90 bc| 2.96 bc|
| T8         | 0.88 bc| 1.38 b| 2.79 cd| 2.84 bc| 3.00 d| 3.00 c| 3.01 cd|
| T9         | 1.04 abc| 1.49 b| 2.81 d| 2.84 bc| 2.97 cd| 2.97 c| 3.11 e|

LSD at P= 5% | 0.17 | 0.11 | 0.09 | 0.14 | 0.09 | 0.10 | 0.09 |

Remarks: The numbers followed by the same letters within the same columns are not statistically significant at p<0.05.

However, Singh et al. (2007); Korbs et al., (2005); Havlin et al., (2005) reported that sugarcane was a long-life crop requiring abundant nutrition, so to meet its nutrient requirement particularly during late stages of the crop growth, fertilizer source releasing gypsum nutrient slowly was required.

Based on measurement of plant nutrient content (Table 5), the higher the dose of fertilizer Application was, the higher the amount of nutrient uptake would be. However, a high nutrient content in the treatment AS fertilizer was not accompanied by an increase in the growth of sugarcane (Table 2-4). This suggests that the excess AS fertilizer had a negative impact on growth of sugarcane (Usman and Sumoyo, 1991; Lestari, 1993; Simoen, 1995; Anonymous, 2007).

At the fifth observation (5 months age), the treatment using the combination of urea-gypsum tended to give the best growth. However, at the last observation (7 months of age) the treatment with AS fertilizer and the AS substitute fertilizer did not show significant difference (P<0.05), especially on the treatments T1, T6, and T9. The application of gypsum gave the additional advantage. It was caused by the Ca nutrient in the gypsum that promotes the sugarcane growth and increases K uptake of sugarcane (Mohandas et al.,1993; Nerilde et al., 2008).

### N and SO$_4^{2-}$ Content of Sugarcane

Based on the analysis of variance (ANOVA) and LSD at P= 5% on the variable of N and SO$_4^{2-}$ content of sugarcane (Table 5), it is shown that the highest N content was in the T6 treatment, while the highest SO$_4^{2-}$ content was in the T3 treatment. Urea and AS are soluble and serve as available N fertilizer for plants (Petrogres, 2006), so they are more easily absorbed by plants than nitrogen source derived from bio-compost. The AS fertilizer containing SO$_4^{2-}$ ion was soluble in the soil, while gypsum as S source had lower solubility than AS fertilizer. In the limited water availability, AS fertilizer was more easily absorbed by plants.

Table 5. N and SO$_4^{2-}$ content of leaf samples as influenced by the treatment of AS fertilizer and its substitutes (urea, gypsum and bio-compost) at four months of age

| Treatments | N     | SO$_4^{2-}$ |
|------------|-------|-------------|
| T0         | 1.09 a| 0.08 a     |
| T1         | 1.74 b| 0.12 bc    |
| T2         | 1.98 cde| 0.13 c   |
| T3         | 1.99 cde| 0.15 d   |
| T4         | 1.93 cd| 0.11 b    |
| T5         | 2.01 de| 0.13 c    |
| T6         | 2.14 f| 0.13 c    |
| T7         | 1.92 c| 0.11 b    |
| T8         | 2.02 e| 0.13 c    |
| T9         | 2.04 e| 0.13 c    |

LSD at P= 5% | 0.08 | 0.01 |

Remarks: The numbers followed by the same letters within the same columns are not statistically significant at p<0.05.

### Soil Chemical Properties

Based on the results of analysis of variance and LSD test at P= 5 %, variables of
the total soil N content in soil sampling at 3 months and 7 months of age showed that the tested treatment significantly (P<0.05) influenced the total N content of soil (Table 6). The control treatment had the lowest nutrient levels compared with the treatments receiving fertilizer application on the observation during 7 months of age. The AS fertilizer treatments had a higher total N content of soil than the treatments using AS substitute fertilizer on the observation done at 3 months of age, but not significantly different from T6, T8 and T9 (Table 6). At the measurement of 7 months, the treatments using AS fertilizer had lower soil N content than the treatment using combination of urea+gypsum+biocompost.

The control treatment had the lowest soil SO$_4^{2-}$ content. The highest soil SO$_4^{2-}$ content was acquired from the treatments of AS substitute fertilizer at a dose of 400 kg urea+ 938 kg gypsum per ha (T6) in soil sampling at 3 months of age. Between AS fertilizer and its substitute treatments, it was shown that SO$_4^{2-}$ content was not significantly different on the lowest dose (T1 vs T4), but on the higher dose (T2 vs T5) it performed significant difference (P<0.05). While at 7 months of age, the treatments using AS substitute fertilizer had the higher soil SO$_4^{2-}$ content than the AS fertilizer treatment, especially at the highest dose. The treatment of T6 and T9 had the highest SO$_4^{2-}$ content, whereas the lowest were T0 (control), T7, and T4 (Table 6).

Based on the soil pH measurement of 3 months, the AS fertilizer treatment at high doses had the lowest pH. The highest soil pH was obtained from the treatment using AS substitute fertilizer at the dose of 200 kg urea + 938 kg gypsum + 3550 kg bio-compost per ha (T9) and T8 (155 kg urea + 730 kg gypsum +2750 kg bio-compost per ha). Meanwhile, the lowest dose of the AS fertilizer treatment (T1) had soil pH that differed significantly (P<0.05) from the AS substitute fertilizer treatment (Table 6). The measurement results of this soil chemical properties suggest that the excessive use of AS fertilizer can give a negative effect to the soil such as the increased content of N and S soil that is able to contaminate groundwater when soil leaches into deeper soil layers, and lower soil pH affects soil fertility (Stites and Kraft, 2001; Ramos et al., 2002; Hattermink, 2005). Thus, the AS fertilizer substitution with environmentally-friendly fertilizer is greatly needed to anticipate a negative effect of AS fertilizer application in a long term.

Tabel 6. Soil chemical properties (N, SO$_4^{2-}$ content and soil pH) as influenced by the treatments of AS fertilizer and its substitutes (urea, gypsum and bio-compost) at 3 and 7 months age

| Treatments | 3 months | 7 months |
|------------|----------|----------|
|            | N (%)    | SO$_4^{2-}$ (mg kg$^{-1}$) | pH H$_2$O | N (%)    | SO$_4^{2-}$ (mg kg$^{-1}$) | pH H$_2$O |
| T0         | 0.11 bc  | 3.98 a   | 6.40 de | 0.07 a   | 2.04 a   | 6.59 bc  |
| T1         | 0.12 c   | 13.94 c  | 6.37 de | 0.08 ab  | 8.06 b   | 6.70 cd  |
| T2         | 0.12 c   | 25.12 d  | 6.20 c  | 0.09 b   | 14.25 c  | 6.34 ab  |
| T3         | 0.12 c   | 30.50 d  | 5.87 a  | 0.09 b   | 18.08 cd | 6.07 a   |
| T4         | 0.09 a   | 10.57 bc | 6.37 de | 0.09 b   | 6.74 ab  | 6.92 de  |
| T5         | 0.10 b   | 12.92 c  | 6.30 cd | 0.09 b   | 12.92 bc | 6.69 cd  |
| T6         | 0.11 bc  | 39.82 e  | 6.00 b  | 0.09 b   | 24.19 e  | 6.38 b   |
| T7         | 0.10 b   | 4.95 ab  | 6.33 d  | 0.11 c   | 4.28 a   | 6.58 bc  |
| T8         | 0.11 bc  | 14.51 c  | 6.47 ef | 0.11 c   | 11.74 bc | 6.89 cde |
| T9         | 0.12 c   | 25.50 d  | 6.57 f  | 0.11 c   | 19.85 de | 7.04 e   |
| LSD at P= 5% | 0.01   | 6.54 | 0.12 | 0.01   | 5.56   | 0.28 |

Remarks: The numbers followed by the same letters within the same columns are not statistically significant at $p<0.05$. 
CONCLUSIONS AND SUGGESTION

This study suggests that the treatments receiving AS fertilizer had the best plant growth at the initial growth stage, but at the end of observation, the treatments receiving AS substitute fertilizer showed similar plant growth with AS fertilizer. Overall, the plant growth treated using AS fertilizer and AS substitute fertilizer was not significantly different. However, the treatment using combination of 400 kg urea + 938 kg gypsum (T6) had the highest N content of leaf. The treatments using AS fertilizer had the lower soil pH, soil N and SO\textsubscript{4}\textsuperscript{2-} content compared with AS substitute fertilizer at the end observation. Thus, it is also suggested that the use of AS substitute fertilizer in sugarcane cultivation containing the similar N and S is recommended to avoid negative impacts on soil fertility and plant growth.

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