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# Effects of organic and chemical fertilizer on growth and vitamin content of *Aloe vera* L. plant in sandy soil

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**Key words:** *Aloe vera*, Manure, Sandy soil, Urea, Vitamin

**Abstract**

This research aims at analyzing the response of *Aloe vera* L. plant on cow manure and urea fertilizer in sandy soil. The research which was conducted in Yogyakarta has three treatments of 10, 20, and 30t $ha^{-1}$ levels of cow manure and five levels of urea fertilizer at 0, 150, 300, 450, 600kg $ha^{-1}$. The research arranged a Randomized Complete Block Design with three replication. The variables measured include yield, growth, and vitamin content. A huge effect was found ($P < 0.05$) between manure and urea. Statistic analysis significant of data was tested by analysis of variant and continued Duncan's Multiple Range Test of $\alpha < 5\%$. The highest yield and growth rate was located at 30t $ha^{-1}$ and 450kg $ha^{-1}$, while the most significant content of pro-vitamin A, vitamin C and provitamin E were found in 30t $ha^{-1}$ and 300kg $ha^{-1}$. Therefore, it can be concluded that 30t $ha^{-1}$ manure and 300 to 450kg $ha^{-1}$ urea are best used to grow plants.

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## Introduction

*Aloe vera* is an ornamental, and medicinal plant used in the cosmetic and food industry. This multifunctional plant is also known as a *Miracle Plant* (Boudreau and Beland, 2006). Darini *et al.* (2013), evaluated the effects of planlets source on growth of *Aloe vera* seedling, and found that its leaves contains fat compounds, proteins, carbohydrates, amino acids, minerals, vitamins, aloins, lectins, alkaloids, saponins, tannins, glukomannan, lignin, and phenolic. The concerted activities of these substances confer to the efficacy of *Aloe vera* leaves which is employed to enhance hair growth, heal skin irritations and wounds, regenerate cells, and act as anti-inflammatory, antioxidant, antiseptic, antibiotic, anti-cholesterol, anticancer, and anti-diabetic. *Aloe vera* leaves are also amongst the ingredients used in phytotherapeutics (Bunyapraphatsara *et al.*, 2007; Yongchaiyudha *et al.*, 2007; Kane, 2007; Nandal *et al.*, 2012; Rajeswari *et al.*, 2014). Phenotypic examination of *Aloe vera* types carried out in Yogyakarta, Indonesia (Darini *et al.*, 2014) showed four types of aloe, namely *Aloe vera* L., *Aloe ferrox*, *Aloe perryi* Baker and *Aloe barbadensis* Mill.

The urgent need for the use of natural plants in food, drugs and cosmetics, has led to an increase in natural agricultural commodities such as aloe vera. According to the World Health Organization, about 80 percent of humans across the globe make use of medicines manufactured from plant extracts. Its usage has increased in Australia, America, and Europe (Widharto, 2011). However, adequate land mass is required for its development but unfortunately, its availability has undergone some changes with a greater percentage of sandy soil reduced. Until recently, the techniques used in handling sandy soil were relatively inadequate. Java Island has a total of 81.000 $km^2$ of seaside area used for agricultural purposes within Yogyakarta with a total area of 3.300 hectares. It consists of sandy textures with low nutrient content, water, cation exchange capacity (CEC), loose structure, high soil temperature, low, evaporation rate and wind speed (Yuwono, 2009).

In order to enhance the characteristics of sandy soil, it is essential to adapt innovative strategies such as municipal biosolids, animal manure, green manure and cover crop, waste from manufacturing processes and compost (Scotti *et al.*, 2015). Animal manure is an essential soil ameliorants that is based on local wisdom. The crop is harvested in the form of leaves (vegetative organs) where nitrogen nutrient is required for the development of vegetative organs, with the application of urea nitrogen fertilizer, and P & K nutrient from cow manure (Khan *et al.*, 2017).

*Aloe vera* has great commercial usage in cosmetics, food, and medicinal industry. However, owing to the fact that marginal lands are the only available land sources, the plant are not cultivated in large scale. To obtain a good economic return with soil health for the next crop yield, a correlation of inorganic and organic source of nutrient is helpful. The sole aims of this experiment were:

1. To examine different fertilizer rates on growth, antioxidant and production of *Aloe vera* in coastal sandy area.
2. To work out an integrated nutrient management practice in order to obtain optimum antioxidant content and yield of *Aloe vera* plant.

## Materials and methods

*Research Area Description*

The experiment was located at Depok Beach, Kretek District, Bantul, Yogyakarta. A temperature of 31-40°C, humidity of 64-75%, 100% light intensity, and 1672.5 mm rainfall was collected for one year. Data was also collected from Integrated Research and Testing Laboratory, Universitas Gadjah Mada, and Plant Production Laboratory, Faculty of Agriculture, Sarjanawiyata Tamansiswa University. The analysis was conducted in (3x5) factorial using the randomized complete block design. The treatments consist of three levels of cow manure (10, 20, and 30t $ha^{-1}$) and five levels of urea (0, 150, 300, 450, and 600kg $ha^{-1}$).

*Seedlings Preparation*

Women farmer group prepared local aloe seedling of 1125 polybags. The seedlings obtained were about 10cm high with four leaves, and were grown in polybags with medium mixture of (1:1) between cow manure and sand.

*Seedlings Planting*

A total of 45 soil plots measuring 3 x 3m were obtained and after 60 days, the seeds were planted at a distance of 60 x 60cm using hoes.

*Manure and Fertilizer Application*

One week prior to the planting, 10, 20, and 30t $ha^{-1}$ of cow manure was used in the plot. Urea fertilizers with rates of 0, 150, 300, 450, 600kg ha-1 were dressed in three stages. Furthermore, one week after planting, 40% of each rate was applied, one month later 30% was applied and in the next month, the remaining 30% was enforced.

*Intercultural Operation*

The area was watered every afternoon using water and gasoline from wells and plastic hoses. Weeding was manually conducted once a month.

*Data Collection*

Two months after transplanting, the fresh and dry weights of the seedlings were measured. Four one-year old plants were sampled from each experimental plot after transplanting. Furthermore, it was measured for its fresh and dry weight, index, crop growth rate and first harvest leaves.

*Biochemical Analysis*

Biochemical observation involving provitamin A and vitamin C were conducted using spectrophotometric methods (Tejasari, 2005), while provitamin E was identified using a high performance liquid chromatograph (JCAM, 2003). Aloe leaves from a year old plant were peeled to obtain its gel quality and determine its vitamin concentration.

*Sample preparation for pro-vitamin A determination*

The leaf gel was homogenized for three hours, extracted in 100ml acetone and then filtered to separate it from the debris. The sample in acetone was extracted with ether three times, and was saponified by adding KOH 15% in methanol. The etheric extract was washed with aquadest, filtered with anhydrous $Na_2SO_4$, and finally analyzed in uv-vis spectrophotometer at 448nm. Standard β-carotene solution was made with concentration of 1, 2, 3, 4, and 5ppm.

*Sample preparation for vitamin C determination*

The leaf gel was macerated in 100ml aquadest with 10ml diluted, and analyzed using uv-vis spectrophotometer at 270nm. Its standard solution was an ascorbic acid.

*Sample preparation to analyze vitamin E*

Tocopherol standard stock solution: approximately 25mg α-tocopherol was dissolved in n-hexane and diluted to 100-mL.

Internal standard solution: Approximately 25mg of 2-metyl-2-phytyl-6-hydroxychroman was dissolved in n-hexane and diluted to 100-mL.

Test solution: A proper test sample was added with internal standard solution and diluted with n-hexane to about 10ml. The solution was filtered through a membrane filter to test for HPLC analysis.

*Statistical Analysis*

Statistical Analysis System (SAS) software version 6.03, was used to subject analysis of variance. Furthermore, the post hoc Duncan Multiple Test was carried out to determine the significant difference between individual means ($P \leq 0.05$).

**Results and discussion**

*Fresh Weight and Dry Weight of Seedling*

*Aloe vera* seedlings were influenced by the use of cow manure and urea fertilizer (Table 1) with values of 57.8g and 7.9g found in 450kg $ha^{-1}$ urea + 30t $ha^{-1}$ cow manure. These results were enormously higher than other treatments. The second was in 450kg $ha^{-1}$ urea + 20t $ha^{-1}$ cow manure, which was similar to 300kg $ha^{-1}$ urea + 20t $ha^{-1}$, 150kg $ha^{-1}$ urea + 30t $ha^{-1}$, 300kg $ha^{-1}$ urea + 30t $ha^{-1}$ and 600kg $ha^{-1}$ urea + 30t $ha^{-1}$.

Meanwhile, the second highest dry weight was achieved in 450kg $ha^{-1}$ urea + 20t $ha^{-1}$ cow manure, which was similar to 300kg $ha^{-1}$ urea+ 20t $ha^{-1}$ , 150kg $ha^{-1}$ urea + 20t $ha^{-1}$, 150kg $ha^{-1}$ urea + 30t $ha^{-1}$, 300kg $ha^{-1}$ urea + 30t $ha^{-1}$ and 600kg $ha^{-1}$ urea + 30t $ha^{-1}$. The minimum fresh and dry weights were 29.4 g and 5.35 g respectively as was noted in 0kg urea + 10t $ha^{-1}$.

**Table 1.** Fresh and dry weight of seedling as affected by cow manure and urea fertilizer, along with the significant differences in treatment are indicated by different letters (Duncan test, α=0.05).

| Urea (kg ha$^{-1}$) | Fresh weight of seedling (g) | | | Dry weight of seedling (g) | | |
|---|---|---|---|---|---|---|
| | Cow manure (t ha$^{-1}$) | | | Cow manure (t ha$^{-1}$) | | |
| | 10 | 20 | 30 | 10 | 20 | 30 |
| 0 | 29.39 e | 32.02 d | 46.95 c | 5.35 d | 6.34 c | 6.54 c |
| 150 | 32.85 d | 39.14 c | 51.49 b | 6.36 c | 6.86 b | 7.78 b |
| 300 | 34.15 d | 51.19 b | 51.11 b | 6.32 c | 7.33 b | 7.48 b |
| 450 | 34.51 d | 54.59 b | 57.77 a | 6.40 c | 7.81 b | 7.88 a |
| 600 | 30.07 e | 44.44 c | 51.66 b | 5.38 d | 6.28 c | 6.88 b |

Organic fertilizer improved CEC, the soil water holding capacity and nutrient availability, which subsequently resulted in a better supply of required nutrients in the soil. The application of 450kg ha$^{-1}$ urea combined with 30t ha$^{-1}$ cow manure supplied enough N for seedling growth. The fresh and dry weight of seedlings was lower when the addition of urea increased to 600kg ha$^{-1}$ owing to the high concentration of N in the soil which affected nutrient uptake. It has been reported that raising the vegetative growth of eggplant is conducted by applying compost and compound NPK fertilizer (Suge *et al.*, 2011). Attarde *et al.* (2012) further argued that the correlation of various fertilizer types is beneficial for the growth of okra plant.

*Fresh and Dry Weight of Plant*

The fresh and dry weight of plant is illustrated in Table 2. The obtained results are consistent with seedling with an increase in nitrogen. The highest fresh (2330 g) and dry weight (466.4 g) of the plant was found in 450kg ha$^{-1}$ urea + 30t ha$^{-1}$ cow manure while the minimum (920g and 184.2g) was obtained in 0kg ha$^{-1}$ urea + 10t ha$^{-1}$. Organic materials helped enhance nutrient cycling and plant availability, in N and P, which enhances vegetative growth and development.

Shams *et al.* (2012) stated that the fresh weight of *Matricaria chamomile* plant increases due to the combination of organic and chemical fertilizer, with Devkota and Jha (2013) having same effect in their research on the yield of *pegagan*. Mama *et al.* (2016) also found that manure and nitrogen fertilizer increases potato growth.

*Growth Index and Crop Growth Rate (C.G.R.)*

Growth index and crop growth rate in Table 3 were 3993% and 11.5% respectively using 30t ha$^{-1}$ cow manure and 450kg ha$^{-1}$. The increasing organic matter could maintain the physical soil fertility and improve nutrient availability to the plant thereby, affecting the vegetative growth. Hokmalipour and Darbandi (2011), in their research stated that applying nitrogen fertilizer increased the growth index of corn plant. According to Tilahun-Tedesse *et al.* (2013), applying manure increased crop growth of rice. While Isah *et al.* (2014) reported that NPK fertilizer enhances crop growth rate of tomato.

**Table 2.** Fresh and dry weight of plant as affected by cow manure and urea fertilizer. Significant difference between the treatment combinations are indicated below (Duncan test, α=0.05).

| Urea (kg ha$^{-1}$) | Fresh weight of plant (g) | | | Dry weight of plant (g) | | |
|---|---|---|---|---|---|---|
| | Cow manure (t ha$^{-1}$) | | | Cow manure (t ha$^{-1}$) | | |
| | 10 | 20 | 30 | 10 | 20 | 30 |
| 0 | 920 e | 1160 d | 1520 c | 184.24 f | 243.60 e | 304.24 c |
| 150 | 1150 d | 1370 c | 1630 b | 230.76 e | 287.74 d | 326.66 c |
| 300 | 1280 d | 1770 b | 2110 b | 268.89 d | 371.72 b | 362.42 b |
| 450 | 1320 c | 1840 b | 2330 a | 277.24 d | 368.78 b | 466.44 a |
| 600 | 1210 d | 1590 c | 1670 b | 254.10 d | 318.68 c | 334.72 c |

**Table 3.** Growth Index and Crop Rate affected by cow manure and urea fertilizer. The difference between means are indicated by variety of letters (Duncan test, α=0.05).

| Urea (kg ha$^{-1}$) | Growth Index (%) | | | Crop Growth Rate (g/m$^2$/week) | | |
|---|---|---|---|---|---|---|
| | Cow manure (t ha$^{-1}$) | | | Cow manure (t ha$^{-1}$) | | |
| | 10 | 20 | 30 | 10 | 20 | 30 |
| 0 | 3030.31d | 3522.73c | 3137.48 c | 4.47 e | 5.93 d | 7.44 c |
| 150 | 3400.76c | 3400.25c | 3665.66 b | 5.61 d | 7.02 c | 7.97 c |
| 300 | 3448.16c | 3657.70b | 3698.61 b | 6.56 d | 9.09 b | 9.37 b |
| 450 | 3424.97c | 3676.76b | 3933.23 a | 6.77 d | 9.02 b | 11.46 a |
| 600 | 3420.65c | 3677.85b | 3332.67 c | 6.22 d | 7.81 c | 8.20 b |

*Leaf Weight of First Harvest*

Leaf weight of first harvest for each treatment was shown in Table 4 with maximum rate recorded at 30t ha$^{-1}$ and 450kg ha$^{-1}$ urea.

Nutrient in organic manure is gradually discharged through mineralization, and maintaining nutrient supply in the soil for a prolonged period results in an increase in plant weight. Enhanced plant growth increased carbohydrate and the leaf weight of first harvest. Furthermore, the correlation of manure and

chemical fertilizer will enhance the production of aloe (Hasannuzzaman *et al.*, 2008), while Phosphorous and Potassium increased its fresh weight (Barandozi *et al.*, 2011). According to Wardani and Melati (2014) applying up to 20t ha$^{-1}$ of goat manure reduced the weight of *tempuyung* (*Soncusarvensis,* L.).

*Vitamin C Content*

The highest absorption of vitamin C was presented jn Table 4, (219.8ppm) recorded in treatment using 300kg ha$^{-1}$ urea + 30t ha$^{-1}$ cow manure. Lower concentration was obtained in the treatment of 150kg ha$^{-1}$ urea + 30t ha$^{-1}$ manure, which was identical to 450kg ha$^{-1}$ urea + 30t ha$^{-1}$ cow manure, 600kg ha$^{-1}$ urea + 30t ha$^{-1}$ cow manure, 600kg ha$^{-1}$ urea + 30t ha$^{-1}$ cow manure, 150kg ha$^{-1}$ urea + 20t ha$^{-1}$ cow manure, and 300kg ha$^{-1}$ urea + 20t ha$^{-1}$ cow manure. The minimum concentration of vitamin C (98.9ppm) was noted in 600kg urea + 20t ha$^{-1}$ cow manure.

**Table 4.** Leaf weight of first harvest and Vitamin C concentration affected by cow manure and urea fertilizer. The significant difference between the treatments are illustrated by different letters (Duncan test, α=0.05).

| Urea (kg ha$^{-1}$) | Leaf weight of first harvest (g) | | | Vitamin C (ppm) | | |
|---|---|---|---|---|---|---|
| | Cow manure (t ha$^{-1}$) | | | Cow manure (t ha$^{-1}$) | | |
| | 10 | 20 | 30 | 10 | 20 | 30 |
| 0 | 492.30f | 528.30e | 614.10c | 161.7c | 139.2 c | 122.3 d |
| 150 | 514.40e | 616.00d | 664.80b | 160.6c | 188.7 b | 195.5 b |
| 300 | 536.60e | 664.60b | 718.80b | 181.6b | 173.3bc | 219.8 a |
| 450 | 548.20e | 708.80b | 816.00a | 191.1b | 154.9c | 172.4 bc |
| 600 | 507.80e | 616.80c | 698.40b | 191.0b | 98.9 e | 190.1 b |

Manure improved soil water holding capacity, protein production, availability and the addition of N fertilizer increased N availability to plant. It also reduced carbohydrate production, and the synthesis of vitamin C. The application lowered rate of manure, and increased the rate of nitrogen, thereby resulting to higher concentration of ascorbic acid. According to Zahradnik and Petrikova (2007) fertilizer increases the ascorbic acid content in cabbage leaf, while Worthington (2010) stated that the organic fertilizer enormously affected vitamin C content in fruit, vegetables, and grains.

*Provitamin A Content*

Cow manure and urea (Tabel 5) influenced the concentration of provitamin A in leaves. Its highest concentration (74.4ppm) was recorded in 300kg ha$^{-1}$ urea + 30t ha$^{-1}$ manure, which was similar to the concentration in the leaves (70.1ppm) and was detected in treatments of 450kg ha$^{-1}$ urea + 20t ha$^{-1}$ manure, or 600kg ha-1 + 10t ha$^{-1}$ manure. These outcomes illustrated that high concentration of provitamin A was obtained if low rate of manure was applied with high rate of urea (300kg ha$^{-1}$).

**Table 5.** Provitamin A and E concentration as affected by cow manure and urea fertilizer. Significant difference between means among treatment combinations are indicated by different letters (Duncan test, α=0.05).

| Urea (kg ha$^{-1}$) | Provitamin A (ppm) | | | Provitamin E (ppm) | | |
|---|---|---|---|---|---|---|
| | Cow manure (t ha$^{-1}$) | | | Cow manure (t ha$^{-1}$) | | |
| | 10 | 20 | 30 | 10 | 20 | 30 |
| 0 | 58.5 c | 28.2 e | 37.8 de | 39.12 e | 42.20 e | 39.41 e |
| 150 | 61.0 b | 61.1 b | 52.9 c | 39.41 e | 52.62 b | 49.74 c |
| 300 | 46.9 d | 43.9 d | 74.4 a | 42.31 e | 56.34 b | 59.37 a |
| 450 | 61.5 b | 70.1 a | 63.3 b | 53.77 b | 45.11 d | 53.87 b |
| 600 | 70.1 a | 64.6 b | 66.6 b | 59.39 a | 36.12 f | 53.78 b |

Karanatsidis and Buova (2009) and Boudh *et al* (2013) in their research on *ashwaganda*, reported that the effect of combining fertilizers increased the carotene (provitamin A) content in pepper plant. Moreover Kavitha *et al.* (2015) found that correlating the various types of fertilizers improved the carotenoids and vitamin A contents in *Amaranthus tristis*.

*Provitamin E Content*

Provitamin E concentration as shown in table 5 indicates that the highest concentration (59.37 and 59.39ppm) is found in two combination treatments, which are 300kg ha$^{-1}$ urea + 30t ha$^{-1}$ manure and 600kg ha$^{-1}$ urea + 10t ha$^{-1}$. The syntheses of vitamin C, provitamin A, and E, are more likely related to the production of carbohydrate. The high rate application of manure and nitrogen fertilizer resulted in reduced vitamin synthesis. According to Hussain *et al.* (2014), organic fertilizer could possibly ameliorates the tocopherol content of raphe- seed, while Renand *et al.* (2014) stated that the correlation between various fertilizer types could ameliorate the phytochemical content of broccoli leaves.

## Conclusion

This research proves that combining cow manure and N fertilizer increases *Aloe vera* growth and *production*. Its significant growth rate was retrieved from combining 30t $ha^{-1}$ cow manure and 450kg $ha^{-1}$ urea, while the highest content of vitamin C, provitamin A and E were obtained using 30t ha-1 cow manure and 300kg ha-1 urea. Therefore, combining 30t $ha^{-1}$ manure and 300 to 450kg $ha^{-1}$ urea on poor soil fertility can grow *Aloe vera* L. plant successfully.

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