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GROWTH RESPONSE OF ALOE VERA PLANTS TO TREATMENT COMBINATION OF KCL FERTILIZER AND COMPOST OF EMPTY FRUIT BUNCHES OF OIL PALM

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ABSTRACT

Empty fruit bunches are excessive wastes in oil palm plantations. There are about 22 - 23 percent of empty fruit bunches produced from the processing of oil palm seeds. While these bunches are simply dumped around the plant, it can be used as a compost in agricultural practices. Research of the utilization of empty fruit bunches of oil palm as compost to *Aloe vera* plants combined with potasium fertilizer (KCl) was conducted in the greenhouse at the University of Bengkulu. The objectives of the research were to determine the growth responses of *Aloe vera* plants to the compost of empty fruit bunches of oil palm with the combination of potassium fertilizer. After twelve weeks of experiments, results showed that there was no significant response of *Aloe vera* plants to the combination of the compost of empty fruit bunches of oil palm with KCl fertilizer. However, the compost of empty fruit bunches itself affected leaf area and leaf fresh weight significantly. Compared to the control that only produced 11.16 gram fresh weight leaf^{-1}, the compost of empty fruit bunches at 10, 20, and 30 tons ha^{-1} increased the leaf fresh weight by about 17, 55, and 28 %, respectively. The increased leaf fresh weight was certainly due to accretion of leaf area by 11, 38, and 16 % at the dose levels of compost of empty fruit bunches of oil palm at 10, 20, and 30 tons ha^{-1}, respectively.

INTRODUCTION

Aloe vera is a species of the *Liliaceae* family which has potential to be developed in tropical areas (Fit 1983). The origin of this plant is from Africa and was grown in Indonesia since the early 17th century. The *Aloe vera* plants have wide adaptability because it grows well from lowland to mountain areas. The optimum growth neccessities of the plants are soils which are rich in organic matters, high intensity of sun exposure, temperature ranging from 16-33 ^{0}C, and the average rainfall of 3,500 mm year^{-1} (Badan Penelitian dan Pengembangan Pertanian 2008). *Aloe vera* is often planted as an ornamental plant in pots or yards because it is traditionally used for medicinal purposes of the household (Yuliani et al. 1996; Sumaryono 2002). Although the *Aloe vera* plant is initially only cultivated as garden plants, in some areas in the Province of West Kalimantan these plants have been cultivated in a commercial scale and has

become an export commodity for the demands of Malaysia, Hong Kong and Singapore (Wahid 2000; Sasli et al. 2008).

Aloe vera can be used as raw materials for cosmetics, traditional medicines for an upset stomach, headache, and itching, and as well as for beverages (Suryowidodo 1988; Yuliani et al. 1996; Sumaryono 2002). The part of the plants used is the stem of thick fleshy leaves which contains clear mucus (Rahayuni et al. 2002). Mucoid fluid from *Aloe vera* contains *aloin*, chemical compounds that function as an antiseptic and antibiotic (Suryowidodo, 1988; Yuliani et al. 1996). Fleshy mucus composition of *Aloe vera* is composed of water (90 %), carbohydrate (4 %), and minerals and amino acids (Yuliani et al. 1996). Minerals found in *Aloe vera* are almost the same as the minerals in spinach, such as potassium, iron, sulfur, phosphorus, silicon, manganese, aluminum, and boron (Fit 1983) .

The propagation of *Aloe vera* is generally by vegetative means through growing new tillers. The advantages of these multiplication ways are that the plants will grow faster compared to generatif propagation (Fit 1983). Growing these plants require intensive practices including fertilization with basic nutrients such as N, P and K. The need for nutrients can be obtained from the growth medium, but for optimum growth the nutrients should be added through fertilization. Potassium is one of the essential nutrients needed by *Aloe vera* plants (Syawal 2009). Potassium may be obtained from the planting medium or from the addition of inorganic or organic fertilizers (Troeh & Thompson, 2005; Jumini & Syammiah, 2006; Wasonowati et al. 2008). The influences of potassium fertilizer (KCl) to the *Aloe vera* plant was investigated by Wasonowati et al. (2008), which showed that the potassium fertilizer from KCl significantly increased the number of leaves, leaf area and leaf fresh weight of *Aloe vera* plants.

Organic fertilizers is a waste of manure or organic materials from plants (Jumini & Syammiah 2006). The organic fertilizers do not only increase the availability of nutrients for plants but it also can improve the physical and biological properties of soil (Troeh & Thompson 2005; Syawal 2009). Availability of manures are limited so that organic materials from plants or waste of crops can become a potential aternative in the future. Empty fruit bunches of oil palm known as TKKS are waste materials in processing fresh fruit bunches of oil palm in the factories (Darmosaskoro & Rahutomo 2003; Wardani 2012). The empty bunches were usually simply dumped around the plant, but in some places it has been used as a mulch in plantations or processed into compost (Darmosarkoro & Rahutomo, 2003). Processing one ton fruit bunches of oil palm will produce 22 - 23% of TKKS. Previous studies has reported some benefits of TKKS when used as organic compost in the cultivation of crops (Wardani, 2012). Compost of TKKS are not expensive and contains macro and mico-nutrients. Chemical composition of compost TKKS contains 42.8, 2.9, 0.8, 0:22, and 0.3 % of C, K_2O, N, P_2O_5 and MgO, respectively; as well as 10 and 23 ppm micro-elements of B and Cu, respectively (Wardani 2012), Nutrient content in each ton of TKKS is equivalent to 3, 0.6, 12, and 2 kg of Urea, TSP, KCl, and Kieserit, respectively. The disadvantage of TKKS used as organic fertilizer in crop production is because of the high C / N ratio, thus it takes a long time for decomposition before being applied in agricultural land. Various composting technology was developed to facilitate the availability of nutrients of TKKS in plants (Wardani 2012). Composted TKKS has high potassium content so it can be used as an organic fertilizer to substitute inorganic potassium fertilizer (Darmosaskoro & Rahutomo 2003).

The objective of this research is to study the utilization of empty fruit bunches of oil palm as organic compost combined with inorganic potassium fertilizers (KCl) to *Aloe vera* plant.

MATERIALS AND METHODS

Research was conducted in the greenhouse of the Faculty of Agriculture at the University of Bengkulu from April to August 2013. Plant materials used were a clone of *Aloe vera* which is widely cultivated in Indonesia, namely *Aloe vera* Chinensis. Seedlings were developed by separation of small tillers and sowed in a polybag sized 8 cm x 15 cm. Media of nursery was a mixture of soil with manure compost by the ratio of 1 : 1. Maintenance of the seedlings were carried out for 2 months, including watering, weeding, and pest and disease controlling.

Two factors evaluated in this research were the combination of compost of empty fruit bunches of oil palm (TKKS) and potassium fertilizer (KCl). Both factors were arranged in a factorial completely randomized design (CRD). The first factor was compost of TKKS included 0, 50, 100, and 200 within 10 kg of planting medium, which were equivalent to the doses of 0, 10, 20, and 30 ton ha $^{-1}$ based on the volume of land in one hectare equivalent to 2 x 10^6 kg. The second factor was potassium fertilizer using KCl consisting of 0, 3.5, 7.0, 10.5 gram per plant which is equivalent to doses of 0, 100, 200, and 300 kg ha^{-1} with a population of 28,000 plants in one hectare. Sixteen treatment combination were repeated 3 times.

Planting medium was prepared by mixing composted TKKS with ultisol soil media. TKKS compost used is the waste from palm oil mill which was dumped and piled around the plant for about 7 months. Ultisol soil was taken from the top layer, crushed and sieved on a sieve size of 0.5 cm. Soil was mixed with compost TKKS in accordance with the treatment doses, and 10 kg was filled into each polybag. Polybags already filled were left in the greenhouse for one week before planting.

Seedlings aged 2 months old with a height of approximately 15 cm were transplanted into the prepared polybags. KCl fertilizer was applied in accordance with the treatment doses by circular array around the plant with a depth of 5 cm. Polybag was then arranged in the greenhouse in accordance with the design used. Plant maintenance included daily watering, weeding done to existing weeds, and pest and disease control done manually.

The growth of *Aloe vera* plants were observed for 12 weeks after transplanting with the observation interval every two weeks. Variables observed were plant height, leaf length, number of leaves (length > 10 cm), and number of tillers (without counting the parent plant). Variables observed at the end of the study or 12 weeks after transplanting included thickness of leaves (mean of thickness at base, middle and end of the leaf which was measured by using a caliper), leaf area (calculated by half of length times width), hardness of leaves (using Penetrometers), leaf fresh weight, and chlorophyll content (measured by Spectrophotometer at 645, 652, and 663 nm).

Data observed were analyzed statistically by analysis of variance (ANOVA) and if there was a significant influence from the treatments, analysis was followed by a further test of Duncan's Multiple Range Test (DMRT) at $P < 0.05$.

RESULTS AND DISCUSSIONS

From the laboratory analysis, results showed that soil media that are used contained 0.10 %, 6.48 ppm, 0.20 me 100^{-1} g, 1.05 g cm^{-3}, 2.15 g cm^{-3}, and 6.5 % of N- total, P_2O_5, K - dd, B / V, BJ, and Moisture, respectively. Similarly, chemical analysis of compost of TKKS contained 0.50, 0.20, 0.35, 6.42, 5.0, and 7.41 % of N, P, K, C, moisture, and pH (H_2O), respectively. During the study, the average air temperature and humidity were 25 – 28 °C and 80-85 %, respectively. No pest and diseases were observed. Weeds were manually controlled by pulling on each occurrence of weeds. Therefore, no harmed effects were caused by weeds to the plants.

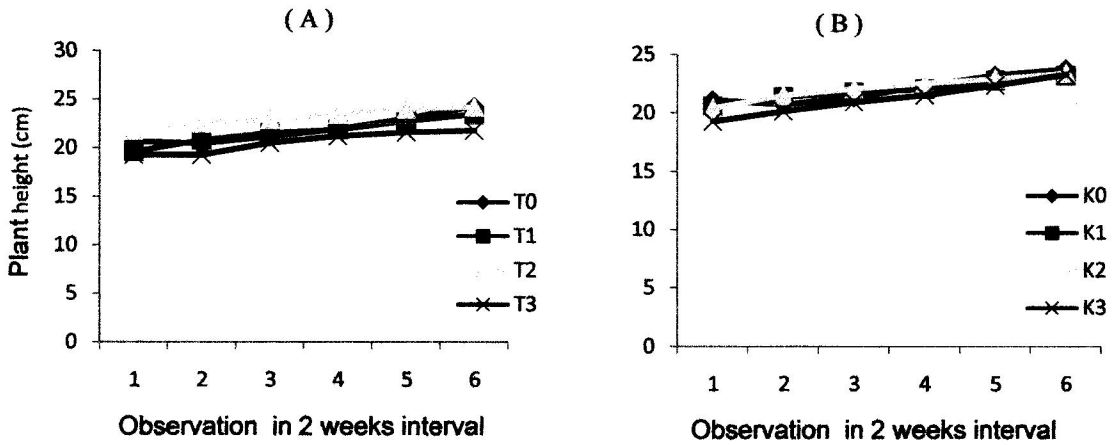

Fig. 1: Growth of plant height of *Aloe vera* in 12 weeks; (A) treated with empty fruit bunches of oil palm at 0, 10, 20, and 30 ton ha^{-1} (T0, T1, T2, and T3, repectively); (B) treated with KCl fertilizer at 0, 3.5, 7.0, and 10.5 g $plant^{-1}$ (K0, K1, K2, and K3, respectively).

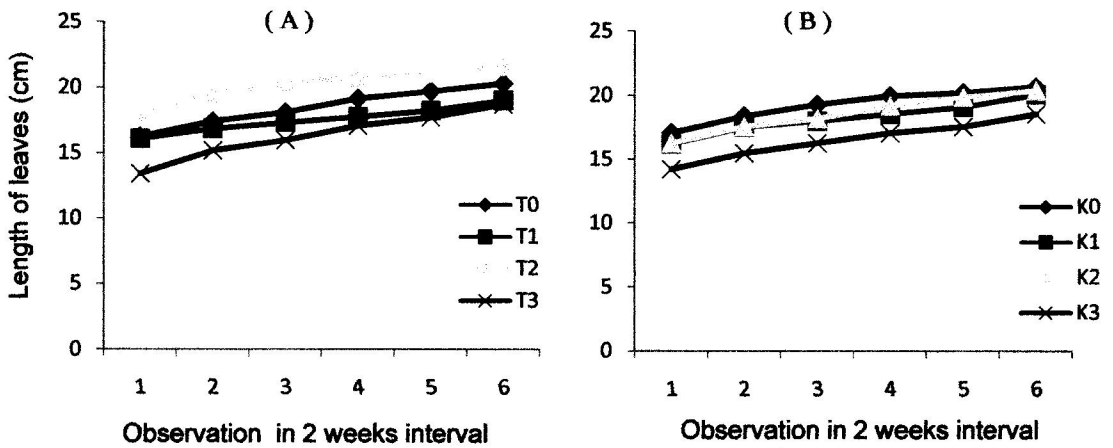

Fig. 2: Growth of length of leaves of Aloe vera in 12 weeks; (A) treated with empty fruit bunches of oil palm at 0, 10, 20, and 30 ton ha-1 (T0, T1, T2, and T3, repectively); (B) treated with KCl fertilizer at 0, 3.5, 7.0, and 10.5 g plant-1 (K0, K1, K2, and K3, respectively).

Growth and development of the plants during the 12 weeks seemed very slow. Growth of plant height both treated with compost of empty fruit bunches of oil plam (TKKS) and potassium fertilizer (KCl) are shown in Fig. 1A and 1B, length of leaves treated with compost of empty fruit bunches of oil plam (TKKS) and potassium fertilizer (KCl) are shown in Fig. 2A and 2B, and number of leaves treated with compost of empty fruit bunches of oil plam (TKKS) and potassium fertilizer (KCl) are shown in Fig. 3A and 3B. Some factors that indicated the slow down of the growth of *Aloe vera* plant in this research were the low nutrient content of N and P_2O_5 in soil media, the trials did not provide any basic fertilizers such as N and P fertilizer, and compost of TKKS used has not been decomposed perfectly so it can not be utilized optimally by plants.

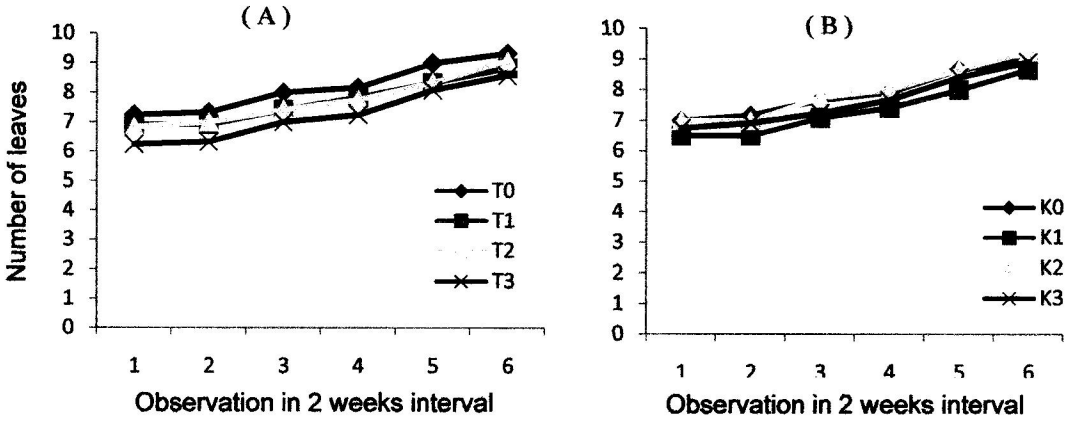

Fig. 3: Growth of number of leaves of *Aloe vera* plants in 12 weeks; (A) treated with empty fruit bunches of oil palm at 0, 10, 20, and 30 ton ha^{-1} (T0, T1, T2, and T3, repectively); (B) treated with KCl fertilizer at 0, 3.5, 7.0, and 10.5 g $plant^{-1}$ (K0, K1, K2, and K3, respectively).

Analysis of variances showed that there was no interaction between the potassium fertilizer (KCl) and compost of TKKS (Table 1). Similar with the single factor of KCl fertilizer indicated no influences to the variables observed, but treatment of compost TKKS showed a significant influence on the variables of plant height, leaf area, and leaf fresh weight; but no significant effect were observed on the number of leaves, number of tillers, thickness of leaves, hardness of leaves, and chlorophyll content (Table 1).

Further analysis by DMRT ($P > 0.05$) on variables affected by compost of TKKS treatment are presented on Table 2. The averages of plant height did not differ significantly among the doses of compost TKKS 0, 10, 20 ton ha-1, but are significantly different from the dose of 30 tons ha-1. A higher dose of compost TKKS appeared to inhibit plant height of Aloe vera at 12 weeks after planting because the average of the lowest plant height (21.8 cm) was observed at doses of TKKS 30 tons ha-1. The phenomenon of decreased plant height with treatment of compost TKKS can not be explained and consistency of data needs to be retested.

Table. 1: F-values from analysis of variance of variables observed at 12 weeks after planting.

Variable observed	Composted TKKS	KCl Fertilizer	Interaction
Plant height (PH)	3,39 *	0,16 ns	1,50 ns
Number of leaves (NL)	2,44 ns	1,36 ns	2,04 ns
Number of tillers (NT)	0,21 ns	0,21 ns	1,12 ns
Leaf fresh weight (LFW)	6,31 *	0,60 ns	1,14 ns
Leaf thickness (LT)	1,91 ns	0,29 ns	1,37 ns
Leaf area (LA)	4,60 *	0,44 ns	1,01 ns
Hardness of leaf (HL)	1,52 ns	0,24 ns	1,46 ns
Chlorophil content (ChC)	0,68 ns	0,58 ns	1,25ns

Remarks: * = significantly influences; ns = non significantly influences.

Treatment of TKKS compost significantly affected leaf area and leaf fresh weight. Compared with the control, the leaf area increased significantly due to treatment of TKKS compost and the maximum increases occurred at 20 ton ha^{-1} with leaf area of 36.18 cm^2 per leaf. Compared to control that had 22.26 cm^2 leaf area, treatment of TKKS compost at 10, 20, and 30 tons ha^{-1} increased the leaf area by 11, 38, and 16 %, respectively. Similarly, the fresh weight variable was also increased significantly at all doses of TKKS compost. The maximum weight was observed at the TKKS compost of 20 tons ha^{-1} which reached 17.33 grams $leaf^{-1}$. Compared to the control that only produced 11.16 gram fresh weight $leaf^{-1}$, the treatment of compost TKKS at 10, 20, and 30 tons ha^{-1} increased the leaf fresh weight by about 17, 55, and 28 %, respectively. Since the variable of leaf thickness was not affected by TKKS compost, thus the significant improvement of leaf fresh fresh weight occurred because of the gain in leaf area.

Table. 2: The effects of empty fruit bunches of oil palm (composted TKKS) to the growth of *Aloe vera* plants observed at 12 weeks after planting.

TKKS (ton ha^{-1})	PH (cm)	NL (pcs.)	NT (pcs.)	LFW (gram)	LT (cm)	LA (cm^2)	HL (Force cm^{-2})	ChC (%)
0	24.26 a	9.3	0.08	11.16 c	5.18	26.22 b	7.03	0.23
10	23.43 ab	8.8	0.08	13.10 bc	5.54	29.17 b	6.96	0.21
20	24.19 a	9.1	0.08	17.33 a	5.85	36.18 a	7.11	0.22
30	21.80 b	8.6	0.08	14.33 ab	5.75	30.36 b	7.63	0.21

Remarks: Numbers followed by the same letters are not significantly different by Duncan Multiple Ranged Test ($P < 0.05$). TKKS=empty fruit bunches of oil plam, PH= plant height, NL=number of leaves, NT=number of tillers, LFW=leaf fresh weight, LT=leaf thickness, LA=leaf area, HL=hardness of leaves, ChC=Chlorofil content.

Most of the leaf fresh weight of *Aloe vera* plant is the water. Water plays a role in turgiditas of cells, so that the cells of the leaf will be enlarged. Jumini & Syammiah (2006) reported thaty the amount of water required in each phase of growth is directly

related to the physiological and environmental factors of the plants. Whenever nutrients are available, the growth cotinues and followed by increasing volume or weight of the plant.

The element of potassium (K) can affect the growth of plants because potassium acted not only as an activator of enzymes in the photosynthetic reactions but also plays a role in the translocation of photosynthate within the plant body. Role of potassium will be evident when other growth components such as N and P are available (Wasonowati et al. 2008). From analysis of variance, it appeared that there is no significant affect of potassium fertilizers on all variables observed in *Aloe vera* plants (Table 3). This phenomenon occured because although plant consumption of potassium was luxurious, without the addition of nutrients N and P, the plants did not respond to the potassium (Troeh & Thompson 2005). The excess consumption of potassium were ineffective on the plant without the addition of other nutrients like N and P.

On the other hand, treatment of TKKS compost was significantly affected by *Aloe vera* plants. Variable observed showed positive response to the treatment of TKKS. Similar response to some other crops such as cabbage, sweet corn, ginger plants had been reported previously (Darmosarkoro & Rahutomo 2003; Wardani 2012). Availability of nutrients content such as N, P, and K in composted TKKS coupled with the soil media can improve the growth of *Aloe vera* plants. Besides contributing macro nutrients, compost TKKS also contains micro-nutrients such as Cu, Zn, Mn, Co, Fe, Bo, and Mo. As an organic materials, TKKS compost can improve physical properties and biological properties of the soil so that plant growth will give a positive response to growth of plants (Troeh & Thompson 2005).

Table. 3: Responses of *Aloe vera* plants observed 12 weeks after planting to KCl fertilizers.

KCl ($kg\ ha^{-1}$)	PH (cm)	NL (pcs.)	NT (pcs.)	LFW (gram)	LT (cm)	LA (cm^2)	HL (Force cm^{-2})	ChC (%)
0	22.52	9.1	0.08	13.25	5.60	29.74	7.03	0.22
100	23.15	9.0	0.08	15.33	5.68	31.01	7.28	0.21
200	24.09	9.0	0.08	13.74	5.41	30.07	7.27	0.22
300	23.92	8.7	0.08	13.69	5.61	31.02	6.96	0.22

Remarks: Variable observed were not affected by potassium (KCl) fertilizers. TKKS = empty fruit bunches of oil plam, PH = plant height, NL= number of leaves, NT = number of tillers, LFW = leaf fresh weight, LT = leaf thickness, LA = leaf area, HL= hardness of leaves, ChC = Chlorofil content.

CONCLUSIONS

The combination of potassium (KCl) fertilizers and compost of empty fruit bunches of oil palm (TKKS) showed insignificant effect on the growth of *Aloe vera*, but treatment of TKKS compost itself influenced the growth of the plants significantly. Compost of TKKS at 10, 20, and 30 tons ha^{-1} consistently improved the leaf fresh weight by 17, 55, and 28 %, respectively. These improvements were correlated to the increased leaf areas because thickness of leaves were not affected by treatment of compost TKKS, whereas

leaf area increased by 11, 38, and 16 % at the dose levels of compost TKKS at 10, 20, and 30 tons ha^{-1}, respectively.

REFERENCES

Badan Penelitian dan Pengembangan Pertanian (2008), Warta Penelitian dan Pengembangan Tanaman Industri, vol. 14, no. 3, pp. 5–6.

Darmosarkoro, W & Rahutomo, S (2003), Tandan kosong kelapa sawit sebagai bahan pembenah tanah, pp. 173 – 186, in W. Darmosarkoro, ES. Sutarta, and Winarna (Ed.), Lahan dan Pemupukan Kelapa Sawit, Medan.

Fit (1983), Aloe vera: The Miracle Plant, Anderson World Books, Inc, Mountain View, Florida.

Jumini & Syammiah (2006), Pengaruh jenis pupuk organik dan jarak tanam terhadap pertumbuhan lidah buaya, J Floratek, no. 2, pp. 107-113.

Rahayuni, T, Sutardi & Santoso, U (2002), Makroenkapsulasi ekstrak lidah buaya (Aloe vera), Uji karakteristik makroenkapsulasi dan aktivitas antioksidannya, Agrosains, vol. 15, no. 3, pp. 391–402.

Sasli, I, Yahya, S, Sudradjat, Setiadi, Y & Sudarsono (2008), Perbaikan pertumbuhan dan kualitas tanaman lidah buaya di tanah gambut dengan aplikasi mikoriza arbuskular dan pemupukan, Bul Agron, vol. 36, no. 3, pp. 248-254.

Sumaryono, W (2002), Penelitian obat tradisional Indonesia dan strategi peningkatannya, Prosiding Seminar Nasional Tumbuhan Obat Indonesia XXI, Surabaya.

Suryowidodo, CW (1988), Lidah Buaya (Aloe vera) sebagai Bahan Baku Industri, Warta IHP, Balai Besar Penelitian dan Pengembangan Industri Hasil Pertanian (BBIHP), Bogor.

Syawal, Y (2009), Efek berbagai pupuk organik terhadap pertumbuhan gulma dan tanaman lidah buaya, J Agrivigor, vol. 8, no. 3, pp. 265-271.

Troeh, FR, & Thompson, LM (2005), Soil and Soil Fertility, 6th edition. Blackwell Pub, UK.

Wahid (2000), Peluang pengembangan dan pelestarian lidah Buaya (Aloe vera), Makalah Forum Pertemuan Kordinasi dan Pengembangan Aneka Tanaman, Dirjen Hortikultura Aneka Tanaman, Deptan, Depok.

Wardani, DE (2012), Tandan Kosong Kelapa sawit (TKKS) sebagai alternatif pupuk organik, viewed 10 July 2014, <http://www.priodicalonline.ac.id.>.

Wasonowati, C, Sudradjat & Yahya, S (2008), Pengaruh pupuk NPK dan Mg terhadap pertumbuhan dan kualitas lidah buaya (Aloe vera chinensis) pada lahan gambut Indragiri Hilir Riau, J Agrovigor, vol. 1, no. 1, pp. 21-28.

Yuliani, S, Winarti, C & Marwati, T (1996), Manfaat lidah buaya dalam perawatan kesehatan dan kecantikan, Balai Penelitian Tanaman Rempah dan Obat Balittro, Bogor.